UN-HABITAT

# Measuring Urban Sustainability: Comparative Analysis of Global Frameworks in Urban Context

**Working document for Park City Initiative**

# ACKNOWLEDGMENTS

**Measuring Urban Sustainability:**
**Comparative Analysis of Global Frameworks in Urban Context**


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# PREFACE

Cities are at the forefront of responding to the combined pressures of rapid urbanization, the climate emergency, and widening social inequalities. These challenges manifest in complex and interconnected ways—from ecosystem fragmentation and heightened exposure to climate-related hazards to inequitable access to public spaces and uneven provision of urban services. Addressing such multidimensional issues requires not only innovative policy responses, but also robust, evidence-based tools that enable cities to measure progress, inform decision-making, and facilitate mutual learning across contexts.

Launched in 2023, UN-Habitat's Park City Initiative (PCI) seeks to bridge locally grounded practices with a holistic international vision for sustainable urban development. The Initiative brings together policy and assessment approaches that support cities in steering urbanization and green space management towards more carbon-neutral, socially inclusive, and climate-resilient pathways. At its core, the Park City Initiative advances an integrated development paradigm that places ecological stewardship, cultural vitality, and human well-being at the centre of urban transformation.

As part of UN-Habitat's ongoing efforts to strengthen the Initiative's analytical foundations, this study undertakes a systematic review and comparative analysis of 26 global and regional urban evaluation frameworks, indices, and assessment tools. The analysis examines their thematic coverage, methodological design, and modes of application, with a particular focus on their relevance to and alignment with the objectives of the Park City Initiative.

This report is not intended as a purely technical comparison. Rather, it serves as a practical resource for urban stakeholders—including local governments, planners, researchers, and international partners—seeking to bridge the gap between global frameworks and local implementation. By mapping similarities, differences, and distinctive strengths across existing tools, the study contributes to several key objectives:

**Clarifying the global landscape of urban assessment tools**, including the identification of gaps, limitations, and underexplored areas, and assessing alignment with global agendas such as the Sustainable Development Goals (SDGs) and the New Urban Agenda.

**Supporting evidence-based enhancement of urban assessment approaches**, by providing actionable recommendations to strengthen indicator design, operational structures, and data collection methodologies.

**Informing urban decision-making**, through the identification of tested and scalable approaches that can support the design and implementation of local policies and programmes.

**Facilitating mutual learning and integration across assessment frameworks**, by highlighting adaptable models and good practices that can be transferred across regions and urban contexts.

**Strengthening capacity for SDG monitoring**, particularly by reinforcing dimensions related to natural resource management and green development in relation to global sustainability and biodiversity targets.

By situating the Park City methodology within a broader ecosystem of urban assessment tools, this study underscores its potential to evolve into a more in-depth and operational assessment toolkit. In doing so, it highlights opportunities for the Park City Initiative to remain locally relevant while also contributing to global knowledge platforms and, where appropriate, feeding into SDG reporting and monitoring systems.

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# EXECUTIVE SUMMARY

This comparative study reviews **26 global and regional urban evaluation frameworks, indices, and assessment tools** to examine their thematic coverage, methodological approaches, and operational models. It focuses on their treatment of core dimensions of sustainable urban development—ranging from biodiversity, green development, and climate mitigation to social inclusion, quality of life, urban resilience, and governance and economic considerations. The study places particular emphasis on how these frameworks align with, and can inform the continued development of, the Park City Assessment Toolkit.

## Key Findings

### a. Broad thematic coverage with significant overlaps

Many frameworks—such as the UN-Habitat Urban Monitoring Framework (UMF), the IUCN Urban Nature Index (UNI), and the Proximity Indicator System—share common structural elements with the PCI, addressing ecological, social, and economic dimensions of urban sustainability. However, each framework reflects **distinct priorities**: UMF emphasizes governance, public service delivery, and SDG alignment; PCI places stronger emphasis on green development, culture, and well-being; and UNI focuses primarily on biodiversity and ecosystem integrity.

### b. Persistent gaps across existing frameworks

Across the tools reviewed, there is **limited integration of quantitative indicators** linking **urban resilience and nature-based solutions to economic value and financing mechanisms**, such as carbon pricing, ecosystem service valuation, and the economic contributions of green infrastructure and mobility. While both PCI and UNI acknowledge ecosystem services, current approaches remain conceptually narrow and methodologically weak in assessing ecological performance and value delivery. In addition, several critical urban planning and enabling parameters—such as neighbourhood safety, land-use efficiency, and education and awareness related to climate resilience and cultural heritage—are absent from PCI but addressed in other frameworks. **Quantitative assessment of governance performance** also remains

underdeveloped across most tools.

**c. Operational design influences impact and uptake**

Evidence from the implementation of frameworks such as the UMF highlights that data availability and institutional capacity remain significant constraints, particularly in developing country contexts. The review further demonstrates that **clear operational models**—including defined workflows, guidance on data collection and validation, and pathways for certification or recognition—are as critical as indicator design in determining the adoption, continuity, and policy impact of urban assessment tools.

## Opportunities for Future Assessment Tool Development

**a. Move from conceptual mapping to analytical monitoring**

Comprehensive frameworks would benefit from evolving into multi-layered, radar-type analytical tools that integrate diverse data sources and enable trend tracking, benchmarking, and scenario analysis.

**b. Address thematic gaps through expansion or specialization**

Future tool development should either expand thematic coverage—particularly in governance, biodiversity health, and economic and financing dimensions—or develop focused, in-depth thematic tools that complement existing comprehensive frameworks by addressing currently under-measured domains.

**c. Strengthen operational models and local adaptability**

Assessment tools should be designed with varying city capacities in mind, offering flexible options for data sourcing, standardization, and application. Further work is needed to develop practical guidance on data collection, validation, and policy use, as well as to explore certification or recognition mechanisms that can incentivize city participation.

**d. Promote cross-framework integration**

Thematic tools such as the Park City Index, UNI, and the Proximity Indicator System can serve as complementary instruments that feed into comprehensive global frameworks, including the UMF and the Global Covenant of Mayors Common Reporting Framework (GCoM-CRF). Aligning thematic indicators with SDG and UMF data requirements would enhance interoperability and enable results to contribute to shared databases and reporting systems.

## Value for Stakeholders

The findings of this study offer:

**Local governments:** practical guidance on integrating Park City and related green development concepts into planning, monitoring, and SDG reporting processes.

**International partners:** insights into aligning locally grounded indicators with global policy frameworks and reporting requirements.

**Urban researchers:** a comparative reference to advance methods for measuring urban sustainability, nature-based solutions, and human well-being.

By refining urban assessment tools in line with these findings, both global organizations and local governments can strengthen their capacity to support greener, more inclusive, and more resilient urban development through evidence-based, action-oriented decision-making.

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# 1 Introduction

The accelerating pace of urbanization presents profound challenges for cities worldwide, particularly in the context of climate change, social inequality, and sustainable development. As urban areas expand, they face a dual burden - managing the ecological consequences of rapid growth and ensuring inclusive, equitable access to urban services and public spaces. These issues are compounded by limited local capacity to track and measure progress toward global sustainability goals such as the SDGs.

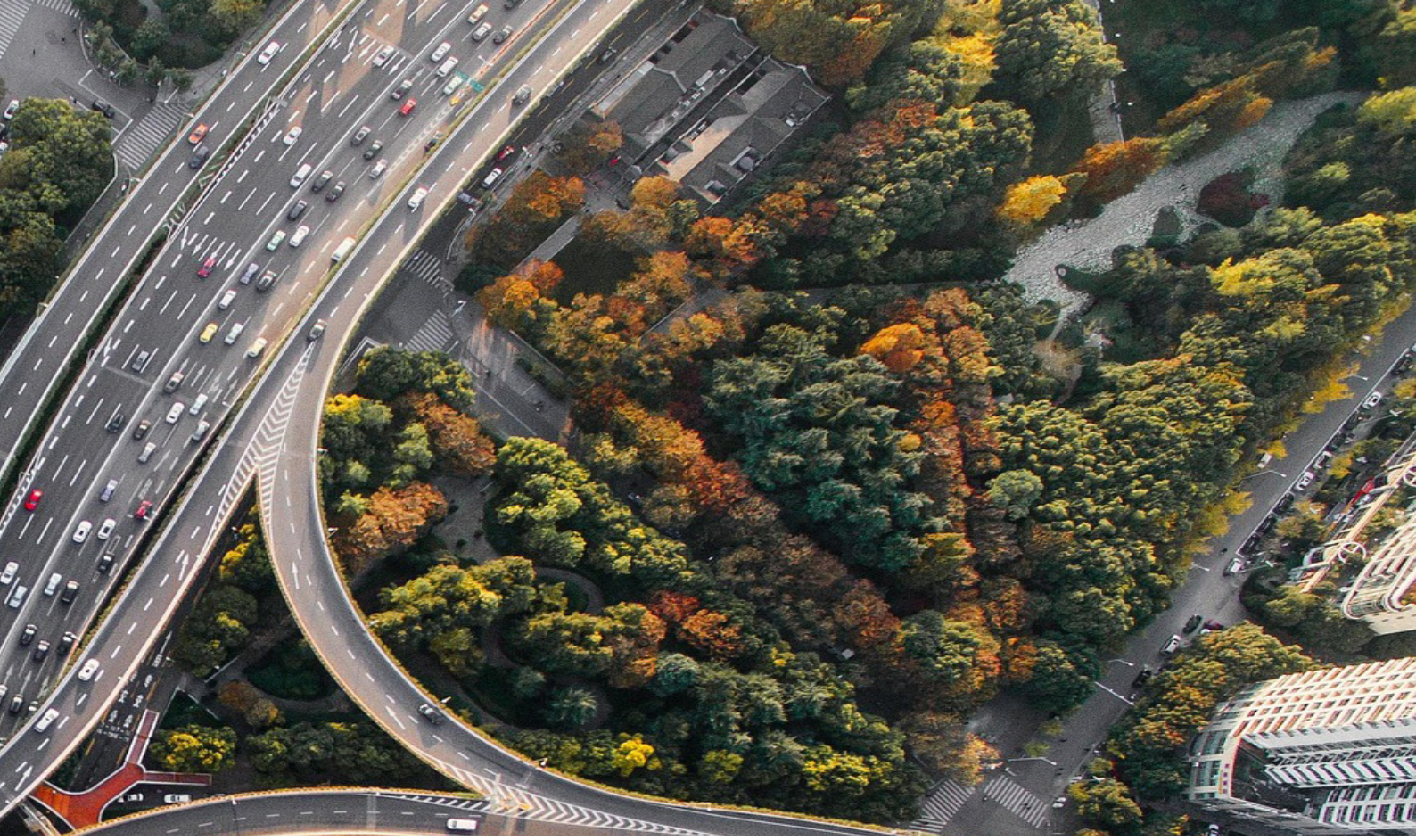
Against this backdrop, the mapping and review of global urban evaluation and assessment tools offer a timely and strategic intervention. By identifying and analyzing tools developed by international organizations, research institutions, and city networks, this study seeks to illuminate how such frameworks can guide local governments and planners toward more integrated, evidence-based, and adaptive decision-making processes.

## 1.1 Project Background

Despite a growing global consensus on “promoting urban transformation and advancing the 2030 Agenda for Sustainable Development,” there remains limited knowledge exchange, experience sharing, and project collaboration among cities pursuing Park City models. This fragmentation hinders the deepening of consensus, mutual learning, and the potential for transformative impact.

In response to this situation, in June 2023, UN-Habitat and RCPCI signed a Letter of Intent (LOI), and this partnership was transformed into the Park City Initiative that formally launched in September 2024 at the 4th Park City Forum, by signing an agreement on jointly developing an analysis tool, establishing a global Park City network, and organize side events, seminars, and trainings.

The Research Center for Park City Index (RCPCI) - with support from the Urban Planning Society of China (UPSC), Sichuan Tianfu New Area Administrative Committee (STNAAC), and Chengdu Design Consulting Group (CDDC)— is a public institution associated to the STNAAC. One of its main mission is to transform insights and solutions from Chinese cities into internationally adaptable and locally customized tools, aligned with Sustainable Development Goal 11 (SDG 11) and the New Urban Agenda (NUA).



The initiative is structured around three components:

**Research and Tool Development**

Conduct comparative analysis of SDG implementation frameworks and the Park City model to identify shared principles and opportunities for alignment.
Develop an analytical tool that helps cities assess the impact of development proposals on SDG outcomes. The tool will be reviewed by UN agencies and experts to ensure broad applicability and quality.

**Network Building**

Establish regional and global networks to support knowledge exchange, advocacy, and the scaling of inclusive and green urban models. UN-Habitat will leverage its global partnerships to promote equity, safety, and gender inclusion in network activities.

**International Activities**

Organize international events, including forums, training sessions, and workshops hosted by UN-Habitat. These platforms will foster inclusive dialogue and promote gender-sensitive and equitable approaches to urban planning and design.
To facilitate the technical work of Park City Initiative, this report serves as a preparatory study for the tool development phase. By comparing SDG implementation frameworks with the Park City model, it aims to align local innovation with global development goals, and identify pathways for cities to contribute more effectively to the SDGs and the NUA.

## 1.2 Purpose of the Study

The systematic review and mapping of global urban assessment tools contribute to a clearer understanding of existing methodologies and their practical value for cities. Such tools form the basis of a shared analytical language, enabling local actions to align with global development agendas while remaining context-sensitive, inclusive, and action-oriented. They also provide structured and scalable approaches that can support evidence-based decision-making and contribute to international reporting systems and databases.

This study serves as a foundation for examining how global and regional assessment frameworks can be better aligned, adapted, and operationalized to support sustainable urban development. For UN-Habitat, its partners, and the Park City Initiative working team, the comparative analysis pursues the following objectives:

### 1.2.1 Clarify the landscape of global urban assessment tools

- Identify the thematic scope and priority areas addressed by existing global and regional tools.
- Highlight gaps, limitations, and underexplored themes in current assessment practices.
- Map commonly applied typologies, indicator categories, and methodological approaches.
- Assess the degree of alignment or divergence among tools in relation to global frameworks, including the Sustainable Development Goals (SDGs) and the New Urban Agenda.
- Explore opportunities for integration, complementarity, and interoperability across tools and approaches.

Scope & focus areas in existing tools
Gaps & underexplored themes
Typologies, indicator categories & methodologies
Alignment/divergence with SDGs & NUA
Potential integration & complementarity

### 1.2.2 Bridge conceptual frameworks and real-world implementation

- Examine how contextual factors—such as governance structures, data availability, and local priorities—influence the applicability and effectiveness of global assessment tools.
- Identify practical challenges faced by cities in adopting and implementing these tools at the local level.
- Reflect on the strengths and limitations of the current Park City Framework through comparative analysis.
- Propose recommendations to enhance the framework's relevance, usability, and adaptability across diverse urban and institutional contexts.

Consider governance, data & local priorities
Identify practical challenges in local use
Reflect strengths & limitations of Park City Framework
Recommend adaptability & relevance improvements

### 1.2.3 Inform the future global toolkit development

- Review the existing 45 indicators within the Park City Framework and provide recommendations informed by international experience and comparative evidence.
- Support the identification of core thematic areas and parameters that are relevant, feasible, and aligned with global SDG monitoring requirements for further development.
- Ensure that future refinements are practical, demand-driven, and action-oriented, enabling application across diverse urban contexts and scalability for international use.

Review and Comment the practices around Park City
Select core SDG-aligned thematic areas
Evidence-based justification & stakeholder input
Ensure cross-context applicability & scalability

For professionals in international organizations, national and local governments, and research institutions, this study supports mutual learning, benchmarking, and peer-to-peer exchange. It promotes the development of assessment frameworks that are both standardized and flexible, enabling meaningful comparison while remaining responsive to regional and cultural diversity.

# 2 Methodology

## 2.1 Research Methods

This study adopted a structured, multi-step research approach to enable a **systematic, transparent, and comparable review** of global and regional urban evaluation and assessment tools. The methodology was designed to examine their **relevance to key dimensions** of sustainable urban development, with a particular focus on biodiversity, urban resilience and risk prevention, green development, climate mitigation and low-carbon transition, and social and cultural inclusion.

**Step 1 – Mapping of Global Frameworks**

The research scope was first defined in line with the thematic priorities of UN-Habitat, UNEP, FAO, and other relevant United Nations entities, international organizations, working on sustainable urban development and urban–nature integration. Based on clearly defined screening criteria, a total of 26 global and regional urban sustainability frameworks and assessment tools were identified for review.

**Method:** A desk-based review was conducted to collect, compile, and categorize information on each tool, focusing on their methodologies, output formats, typologies, and application approaches. This stage provided a foundational understanding of the diversity of tools and their relevance to urban green and urban-nature integration.

**Step 2 – Review and Filtration**

The identified tools were grouped into six thematic categories according to their primary focus areas. From this initial mapping, a subset of five benchmark frameworks was selected for in-depth analysis, based on criteria including thematic relevance, methodological robustness, operational maturity, and global applicability.

**Method:** Tools mapping and thematic review were applied to structure the selection process, ensuring a balanced representation of thematic areas.

**Step 3 – Analysis**

The benchmark frameworks were systematically compared with each other to assess their alignment with Urban Green and Park City's core values, indicator logic, and conceptual structure. This analysis focused on identifying thematic overlaps, methodological similarities, and distinctive features across frameworks.

**Method:** A semantic analysis was performed, complemented by the creation of a "Commonality–Divergence Matrix" to systematically highlight shared strengths and distinctive features.

**Step 4 – Matching**

Indicators from the six benchmark frameworks were mapped and cross-referenced to explore opportunities for integration, refinement, or adaptation with the SDG targets and UMF.

Method: Indicator matching techniques were applied to assess compatibility and identify gaps or redundancies among the on-going global practices of frameworks.

**Step 5 – Synthesis and Recommendations**

Findings from the previous steps were synthesized to generate strategic recommendations for further developing an assessment tool. The recommendations focus on strengthening thematic completeness, methodological rigor, operational feasibility, and international applicability, with the aim of supporting cities in assessing the impacts of development initiatives on Sustainable Development Goal (SDG) outcomes.

## 2.2 Scope of the study

This study reviews and analyzes global and regional urban assessment frameworks, indices, and analytical tools that have emerged over the past decade. The analysis is anchored in the five pillars of the Park City Index—**Harmonious Coexistence, High-Quality Life, Green Development, Cultural Revitalization, and Modern Governance**—and examines their conceptual linkages with established international frameworks, including the UN-Habitat Urban Monitoring Framework (UMF), the Urban Proximity Index, and UNESCO's Culture|2030 Indicators. To ensure international relevance, clarity, and comparability, these pillars are reinterpreted using internationally recognized terminology commonly applied in global urban policy and monitoring systems.

To guide the comparative analysis, the study organizes assessment themes into six interrelated thematic areas that reflect both the Park City pillars and prevailing global urban development priorities:

- Urban Sustainability
- Biodiversity, Ecosystems, Urban Resilience & Risk Prevention
- Green Cities, Climate Mitigation & Low-Carbon Development
- Social and Cultural Inclusion & Quality of Life
- Urban Finance
- Governance

These thematic areas are grounded in widely used classifications and conceptual frameworks familiar to international organizations, enabling consistent comparison across tools and alignment with global policy agendas.

## 2.3 Selection Criteria

**Alignment with Global Frameworks** - Tools must link clearly to global agendas such as the UN Sustainable Development Goals (especially SDG 11) and the New Urban Agenda, supporting relevance and

comparability.

**Context-Sensitive and Scalable** - Frameworks must be adaptable to diverse urban contexts (e.g., developed vs. developing cities, large vs. small cities), and must clearly define methodologies, data sources, and assumptions.

**Applicability Beyond a Single Context** - Tools must be designed with the potential to be applied at the national level and scalable to other countries or regions worldwide.

**Data-Driven but Practical** - Tools must use reliable, accessible, and consistent data sources (e.g., official statistics, satellite imagery, citizen science) and strike a balance between quantitative and qualitative indicators.

**Complete and Practically Applied** - Only frameworks or tools that have been officially launched are included; those still under development are excluded. It is preferred that the tool has been piloted in cities or produced reports demonstrating its practical application.

By applying these selection criteria, the study establishes a focused and actionable analytical basis for examining urban green, low-carbon, and resilience-related measurement and monitoring approaches, and for informing the development of an adaptable and globally relevant urban assessment toolkit.

## 2.4 Research Methods

This study combines traditional qualitative review methods with digital and computational analysis techniques, including AI-supported semantic decoding and comparative analysis. The integrated approach enables both conceptual interpretation and systematic comparison across multiple urban assessment frameworks.

### Thematic Analysis

Thematic analysis was applied as a qualitative method to identify, classify, and interpret recurring themes across indicator definitions and framework structures. In this study, it supports the synthesis of thematic priorities, indicator groupings, and conceptual emphases across the reviewed global and regional frameworks, providing a structured basis for comparison.

### Semantic Analysis

Semantic Network Analysis was used to assess latent conceptual similarities between indicators drawn from different frameworks. Textual definitions and, where applicable, indicator formulas were analyzed using natural language processing techniques. Each indicator was transformed into a vector representation through language embedding models, enabling the comparison of conceptual proximity beyond surface-level terminology.

### Commonality-Divergence Matrix

A Commonality–Divergence Matrix was developed to systematically compare the thematic coverage of the Park City Index with established global frameworks. Using term frequency–inverse document frequency (TF-IDF) weighting and cosine similarity measures, indicator definitions were vectorized and compared, generating normalized similarity scores ranging from 0 to 1. Heatmaps were then used to visualize areas of convergence and divergence, supporting a transparent and replicable comparison of Park City indicators against global thematic frameworks.

### Indicator matching

Indicator matching involved the structured alignment of indicators from the Park City Index with those from selected benchmark frameworks, such as the Urban Monitoring Framework (UMF) and the IUCN Urban Nature Index. Matching was conducted based on thematic focus, measurement scope, and intended policy relevance. This process facilitated the identification of conceptual overlaps, gaps, and structural differences, enabling a more granular and actionable comparative assessment.

Thematic interpretation allows researchers to distill large, complex sets of indicators into coherent themes, enabling a high-level understanding of how different frameworks conceptualize urban performance. It is widely used in sustainability assessment to capture cross-cutting issues.

Semantic similarity applies Natural Language Processing (NLP) techniques to measure the conceptual distance between indicator definitions. Using vector embeddings (e.g., Sentence-BERT) and similarity metrics (e.g., cosine similarity), it can reveal latent linkages that are not apparent from thematic grouping alone .

[1] Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa
https://doi.org/10.1191/1478088706qp063oa

[2] Reimers, N., & Gurevych, I. (2019). Sentence-BERT: Sentence Embeddings using Siamese BERT-Networks. In Proceedings of the 2019 Conference on Empirical Methods in Natural Language Processing.
https://aclanthology.org/D19-1410/

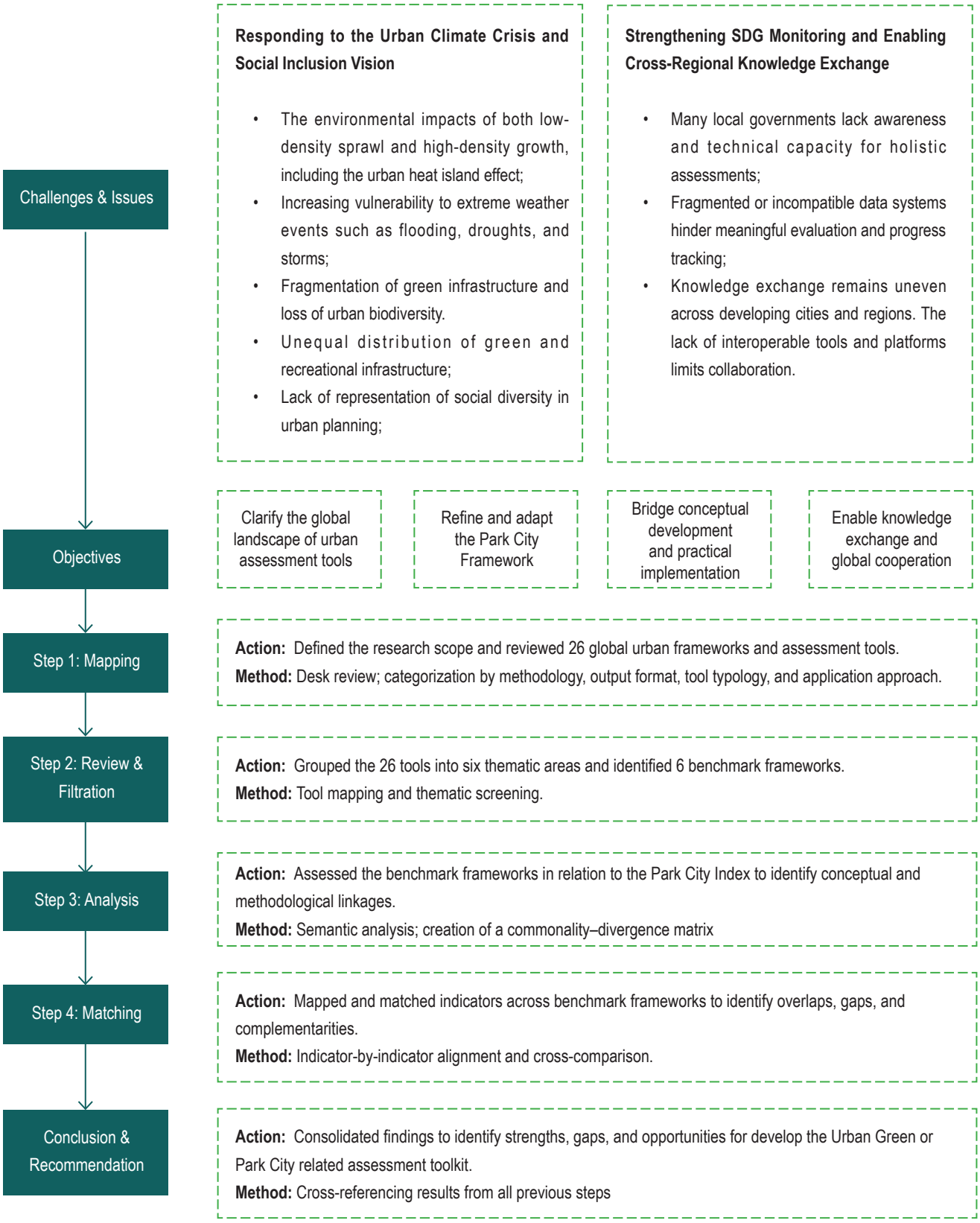



Figure: Methodology Flow Diagram
(Source: Drawn by the project team)

## 2.5 Linkages to implementing SDGs and NUA

The Park City Index offers valuable support for SDGs reporting, particularly in tracking urban sustainability, inclusivity, and ecological resilience across multiple goals. By providing 45 multidimensional indicators—ranging from environmental health and cultural heritage to governance and innovation—the index directly aligns with key SDG targets.

To explore how the Park City Index indicators align with Sustainable Development Goals (SDGs), we assigned quantitative relevance scores (ranging from 0 to 1) between selected SDGs and ten specific indicators based on their definitions. Each score reflects the semantic and functional alignment of an indicator with the objectives of an SDG.

SDG 11 (Sustainable Cities and Communities) shows the strongest cumulative linkage (total score: 3.25) with indicators focusing on urban livability and infrastructure, particularly:

- Indicator 15: Urban park participation (0.85)
- Indicator 14: Green travel level (0.80)
- Indicator 13: Public service friendliness (0.90)

SDG 13 (Climate Action) and SDG 15 (Life on Land) both demonstrate significant associations with ecological indicators:

- Indicator 20: Urban carbon sequestration effectiveness is a major contributor to SDG 13 (0.9) and SDG 15 (0.8).
- Indicator 5: Species richness and Indicator 2: Soil and water conservation are strongly aligned with SDG 15.

SDG 6 (Clean Water and Sanitation) and SDG 12 (Responsible Consumption and Production) are supported by:

- Indicator 1: Water resource security
- Indicator 10: Solid waste disposal friendliness
- Indicator 22: Ecological water-use intensity

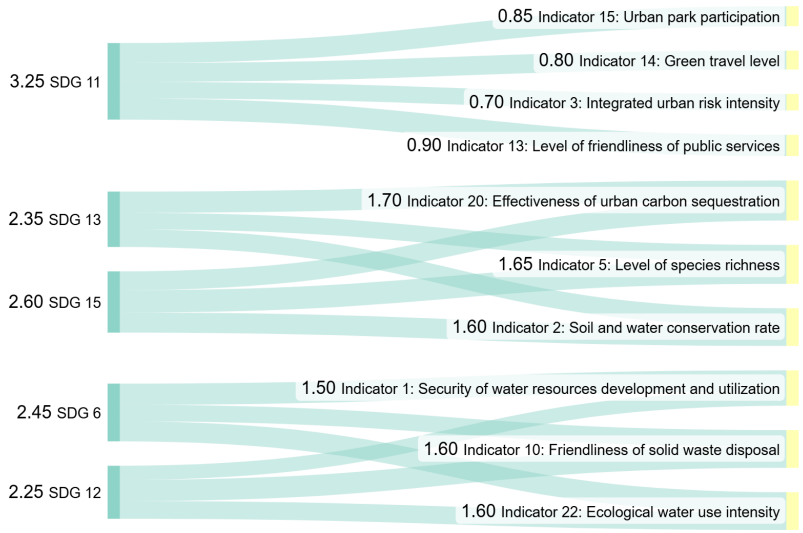



Figure: Contribution to SDGs Reporting
(Source: Drawn by the project team)

# 3 Overview of Urban Evaluation Tools

This study reviewed and analysed **26 frameworks and tools** based on their alignment with the thematic focuses of the Urban Monitoring Framework (UMF) and the Park City Initiative (PCI)'s values, with a particular emphasis on evaluating urban green and nature-based integration.

To capture the multi-dimensional aspects of urbanization progress and the disaggregated elements across thematic or cross-cutting fields, the selected tools span a range of types - from indicator frameworks and assessment tools to checklists and digital platforms.

The criteria for collecting and filtering these tools included:

- Alignment with the **objective** of evaluating urban development, including spatial structure and networks, urban efficiency, nature-related contributions, well-being, and institutional or governance systems.
- The **capacity** to incorporate quantitative data for evidence-based evaluation or analysis.
- A clear **methodology** for data collection, standardization, and analysis leading to meaningful valuation.
- **Relevance to the global context**, with adaptability to various regional settings (international or at least regional in scope).

**General Urban Development**

Urban Monitoring Framework (UMF)

Developed by UN-Habitat, the Urban Monitoring Framework (UMF) serves as a globally recognized, comprehensive instrument for monitoring urban development. It aligns with the broad scope of the Park City Index by covering social, economic, environmental, cultural, and governance aspects through 78 indicators. Its multidimensional structure supports integrated monitoring of cities' performance toward achieving SDG 11. As a general-purpose framework, UMF enables holistic benchmarking across varied urban functions, making it the most suitable match for the general thematic focus.

**Biodiversity**

Urban Nature Index (UNI)

The Urban Nature Index (UNI) developed by IUCN was selected as the benchmark framework in the biodiversity domain. It provides a systematic approach to assess urban nature through indicators on habitat connectivity, ecosystem condition, and biodiversity mainstreaming. UNI directly supports cities in measuring their progress on ecological resilience and nature-based solutions.

**Green Development, Climate Mitigation & Low Carbon**

LEED v4.1 Cities and Communities: Existing Cities

LEED v4.1 for Cities and Communities established by the USGBC is a framework focused on sustainable infrastructure and climate mitigation. It offers 41 performance-based indicators across domains such as energy use, emissions reduction, water efficiency, and green infrastructure. As a climate-focused framework, LEED supports the transition toward low-carbon, resource-efficient urban systems.

**Social & Cultural Inclusion & Life Quality**

Global Proximity Indicator System

The Global Proximity Indicator System developed by the Global Observatory for Sustainable Proximities focused on the concept of the 15-minute city through 24 indicators. It emphasizes equitable access to essential services, social infrastructure, and community well-being. Its relevance lies in addressing spatial inequality and fostering inclusive urban development—a critical component of just and liveable cities.

**Urban Resilience & Risk Prevention**

Urban Resilience Scorecard for Cities

The Urban Resilience Scorecard developed by UNDRR offers a multi level assessment of disaster preparedness and adaptive capacity. The selected Level 2: Detailed Assessment includes 110 indicators across 10 essentials, covering areas such as emergency response, infrastructure vulnerability, risk-informed governance, and post-disaster recovery. Its integration into the study enhances the comparative understanding of how cities can withstand and recover from shocks and stresses.

**Finance & Economy**

Climate Bonds Resilience Taxonomy Methodology (CBRT)

The Climate Bonds Resilience Taxonomy Methodology (CBRT) developed by the Climate Bonds Initiative, provides a taxonomy for assessing adaptation and resilience in infrastructure investment. With 65 indicators across 10 subsectors, the framework captures risk identification, system flexibility, and financial governance—key elements in building economic resilience. Positioned within the financial and economic thematic focus, CBRT offers insights into how cities and assets can remain viable under climate pressure, aligning with the Park City Index's financial risk management and sustainable investment priorities.

A summary of these 26 tools is provided below. For more detailed descriptions and characteristics of each tool, please refer to Annex 1.

| Thematic Category | Framework/Tool | Lead Organization | Initial Release | Latest Update | Scale | Geographical Focus |
|---|---|---|---|---|---|---|
| **Urban Sustainability** | Urban Monitoring Framework (UMF) | UN-Habitat | 2020 | 2022 | City | Global |
| | Park City Index (PCI) | Research Center of Park City Index | 2022 | 2024 | City | China |
| **Biodiversity & Ecosystem** | Urban Nature Index (UNI) | IUCN | 2021 | 2023 | City | Global |
| | City Biodiversity Index (CBI/ SBI) | Singapore National Park Board | 2008 | 2024 | City | Global |
| | BioSampa Index | Municipal SVMA of Sao Paulo | 2016 | 2023 | City | Brazil |
| **Urban Resilience & Risk Prevention** | City Resilience Index | Arup + Rockefeller Foundation | 2015 | 2019 | City | Global |
| | Urban Resilience Scorecard | UNDRR | 2015 | 2017 | City | Global |
| **Green City & Climate Mitigation & Low Carbon** | ICLEI Climate Neutrality Framework | ICLEI + ACCCRN | 2018 | 2020 | City | Global |
| | Green City Index | Siemens + EIU | 2009 | 2009 | City | EU → Global |
| | Common Reporting Framework (GCoM – CRF) | Global Covenant of Mayors (GCoM) | 2018 | 2024 | City | Global |
| | Green Growth Indicators (OECD) | Organisation for Economic Co-Operation and Development (OECD) | 2011 | 2017 | National | Global |
| | LEED for Cities | US Green Building Council (USGBC) | 2017 | 2021 | City | USA → Global |
| | Environmental Performance Index (EPI) | Yale Center for Environmental Law & Policy and CIESIN– Columbia University, in collaboration with WHO, WEF, and the EU JRC | 2006 | 2024 | National | Global |
| | EU Green City Tool | European Commission | 2009 | 2009 | City | EU |
| **Social & Cultural Inclusion & Life Quality** | OECD Better Life Index | OECD | 2011 | 2020 | Nation | OECD/Global |
| | Proximity Indicator System | IAE Paris Sorbonne Business School (Chaire ETI), C40 Cities, United Cities and Local Governments (UCLG) and UN-Habitat | 2023 | 2024 | City / Neighbor-hood | Global |
| | Social Inclusion Index | UNDP, Development Bank of Latin America (CAF) | 2016 | 2019 | City | LAC |
| | UNESCO Culture 2030 | UNESCO | 2019 | 2025 | City/ National | Global |
| | Quality of Life Index (QoLI) | UN-Habitat, UNECA | 2019 | 2023 | City | Global |
| | ISO 37120: Indicators for City Services & Quality of Life | International Organization for Standardization (ISO) | 2014 | 2018 | City | Global |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Finance** | Climate Resilience Principles | Climate Bonds Initiative | 2021 | 2024 | City | Global |
| | CDP Cities, GCoM CRF | CDP, GCoM | 2016 | 2024 | City | Global |
| | Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) | Natural Capital Project (Stanford University) | 2007 | 2024 | Site–National | Global |
| **Governance** | International Guideline of Urban Territorial Planning (IG-UTP) - Planning System Assessment | UN-Habitat | 2015 | 2023W | National/ subnational | Global |
| | SDG Cities diagnostic tools | UN-Habitat | 2021 | 2025 | City | Global |
| | GAF-MTR (UN-Habitat) | UN-Habitat | 2020 | 2020 | Region/ City | Global |

Table: Overview of reviewed tools in relation to green development and urban biodiversity in recent decade

## 3.1 Typology of Urban Evaluation Tools

### 3.1.1 Review of previous research

#### a) The Rise of Indicator Frameworks and Evolution toward Multidimensional Urban Assessment

In recent decades, following global agreements such as Agenda 21 (UN, 1992), the concepts of sustainability and sustainable development have gained increasing prominence across public, academic, and private sectors (Gallopín, 1996; Hak et al., 2016). Sustainable urban development has since emerged as a central pillar of this global agenda (UN, 2017), prompting widespread efforts to define, measure, and monitor sustainability at the city level. To address the complexity and multidimensional nature of urban sustainability, a wide range of indicator sets and assessment frameworks has been developed, translating abstract sustainability concepts into more practical and operational tools (Christen & Schmidt, 2012).

While early assessment efforts focused primarily on **environmental indicators and monitoring systems**, more recent frameworks have expanded to incorporate social, economic, and governance dimensions. This evolution reflects a growing recognition that urban sustainability cannot be adequately captured through single-sector approaches, but instead requires **integrated and multidimensional assessment frameworks**. Indicators thus function as **structured tools** that simplify complex decision-making processes, guiding stakeholders toward clearer priorities, informed choices, and targeted urban development outcomes.

#### b) Defining Indicator Frameworks and Their Core Functions

Despite their widespread use, the definition of "indicator frameworks" remains **uneven** (Gallopín, 1996). Halla and Merino-Saum (2022) conceptualize indicator frameworks as **"informational conductors"** that connect abstract sustainability concepts with measurable metrics. They identify six core purposes:

- Deepening conceptual understanding
- Identifying gaps and blind spots
- Structuring complex information
- Enabling scaling across contexts
- Anchoring abstract ideas to metrics
- Supporting communication and stakeholder engagement

This framing highlights that indicator frameworks are not merely technical instruments but also conceptual and communicative devices. Indicators play a vital role in decision-making. Scientifically grounded indicators help convey clear messages to policymakers (Hak et al., 2016), guide national and international decisions (Gallopín, 1996), and support adaptive governance in uncertain environments (Pupphachai & Zuidema, 2017). However, because indicators depend on available data, they are vulnerable to bias when data are incomplete or unreliable. As primary "data carriers," they require robust, regularly updated datasets (Merino-Saum et al., 2020) to maintain policy credibility (Hak et al., 2016).

#### c) Typologies of Frameworks: Conceptual, Procedural, and Utilization Perspectives

The question of **what constitutes a "good" indicator** is central to the design and effectiveness of urban assessment frameworks. Merino-Saum et al. (2020) argue that indicators should be adaptable to local contexts and capable of operating across multiple analytical logics, ideally organized through matrix-like structures that allow for both thematic integration and analytical flexibility. Similarly, Sharifi's (2020) typological analysis of 34 urban assessment tools—particularly within the domain of smart city frameworks—highlights the importance of understanding how indicators are selected, structured, and operationalized. Despite substantial variation in geographic scope, thematic emphasis, and assessment methodologies, Sharifi identifies **strong commonalities across frameworks**, noting the predominance of index-based approaches and broadly similar thematic architectures.

Beyond indicator composition, several scholars and institutions have proposed typologies that classify frameworks according to their governance functions and modes of influence. In a joint paper by UN-Habitat and UCL, urban design governance tools are classified along two dimensions: **quality culture versus quality delivery**, and **formal versus informal mechanisms**. Quality culture tools aim to foster shared values, norms, and understanding of good urban design, shaping the broader decision-making environment. In contrast, quality delivery tools directly influence the design and implementation of specific projects and places. Formal tools rely on statutory powers, such as regulations or planning codes, while informal tools operate through soft influence, including guidance documents, design reviews, or awards. This classification results in three main categories: informal quality culture tools, informal quality delivery tools, and formal quality delivery tools, highlighting the varied pathways through which frameworks can shape urban outcomes.

A complementary perspective is offered by Henrik Gudmundsson, who distinguishes between **Conceptual frameworks** and **Utilization frameworks** within environmental indicator systems. Conceptual frameworks define how indicators are selected, justified, and differentiated from raw data, emphasizing their role as meaningful signals rather than isolated measurements. They typically include technical definitions, metrics, and conceptual linkages. Utilization

frameworks, by contrast, focus on how indicator information is applied in practice, particularly in relation to accountability and policy feedback mechanisms. Gudmundsson identifies three types of utilization frameworks: Information frameworks, which present data without enforcing its use; Monitoring frameworks, which track progress and enable adaptive policy adjustments; and Control frameworks, which directly guide policymaking through performance targets and formal accountability mechanisms. These categories vary in the strength of their linkage between indicators and policy action.

Building on this distinction, Pekka Halla and Albert Merino-Saum further differentiate between **Procedural frameworks** and **Conceptual frameworks**. Procedural frameworks describe the methodological processes used to measure specific concepts and often consist of sequenced stages supported by dedicated tools. Conceptual frameworks, in contrast, are centered on the underlying concept being assessed. Based on an analysis of 67 urban sustainability indicator initiatives, the authors identify six key purposes served by conceptual frameworks. As a mind map, a framework helps redefine and clarify the core dimensions of the concept to be monitored. Acting as a radar, it guides indicator selection by revealing thematic gaps and redundancies. When viewed as a skeleton, the framework structures and organizes complex information to ensure coherence. As a scale model, it illustrates interactions among system components. Serving as an anchor, it connects abstract metrics to concrete conceptual meanings. Finally, as a business card, it communicates the initiative's identity and focus, supporting stakeholder engagement and differentiation from other frameworks.

Within this broader landscape, **composite indicators** occupy a prominent position in policy analysis, cross-country comparison, and benchmarking. The OECD's Handbook on Constructing Composite Indicators (2005) defines composite indicators as aggregates of individual indicators combined into a single index, enabling the synthesis of multidimensional phenomena into a form that is easily communicable to policymakers and the public. Such indices are particularly useful for addressing broad, policy-relevant concepts such as urban sustainability or liveability. However, the Handbook cautions that composite indicators carry risks of oversimplification and misinterpretation, potentially masking trade-offs or leading to misleading conclusions if methodological choices are not transparent. Feldmeyer et al. (2020) echo this concern in the context of disaster and extreme-event indicators, emphasizing the importance of a two-step validation process to improve indicator selection, enhance transparency, and reduce uncertainty.

Parallel to these methodological debates, the role of green infrastructure, nature-based solutions (NBS), and urban biodiversity has expanded significantly within sustainability discourse. This shift has prompted the development of specialized indicator frameworks focused on urban nature and ecosystem services. The health, climate, and social benefits of green infrastructure are now well documented (Nieuwenhuijsen et al., 2017), underscoring the need for assessment frameworks capable of capturing the aggregate and multidimensional value of green space rather than evaluating it through a single lens. Emerging methods, including GIS-based analysis and user surveys, enable richer datasets that go beyond mere presence to assess quality, quantity, and accessibility, supporting the development of more nuanced indicators (Knobel et al., 2019).

At the same time, differences in conceptualization and measurement across frameworks can lead to divergent policy recommendations. Raymond et al. (2017) demonstrate how NBS impact assessment frameworks emphasize links between ecosystem services, co-benefits, and multiple knowledge systems, highlighting impacts across spatial and temporal scales. In contrast, the MAES framework focuses more narrowly on biodiversity status, ecosystem condition, and service provision, resulting in different policy priorities. These contrasts highlight the importance of selecting indicators and frameworks based on the objectives of the intervention, the type of action being assessed, data availability, analytical capacity, and the scale of analysis.

Finally, the translation of indicators into **operational decision-support tools** raises additional methodological considerations. Falconer (2018), focusing on a three-stage process of indicator modelling and interactive visualization, illustrates how indicators can be transformed into spatially explicit models using GIS. While such approaches can enhance decision-making by presenting accessible and scenario-based visual outputs, Falconer notes that their technical complexity, time intensity, and skill requirements may limit their suitability in certain contexts. This reinforces the broader conclusion that indicator frameworks must balance analytical sophistication with usability, ensuring they remain fit for purpose within real-world planning and policy environments.

### d) Synthesis

Overall, the literature demonstrates that indicator frameworks are essential tools for addressing the complexity of sustainable urban development. Their effectiveness, however, depends on clear conceptual foundations, robust methodologies, reliable data, and sensitivity to local context to ensure they support meaningful, evidence-based decision-making.

### 3.1.2 Typology of Urban Evaluation Frameworks and Tools

Building on the literature review and the systematic comparison of global urban assessment practices, this study classifies urban evaluation frameworks and tools according to two complementary dimensions: (i) how data are generated, structured, and operationalized within assessment systems, and (ii) the form and function of outputs produced for policy, planning, and decision-making.

This typological approach responds to recurring findings in the literature that differences in conceptual design, data logic, and output formats significantly influence how tools are applied, interpreted, and translated into action (Gudmundsson; Halla & Merino-Saum; Sharifi). It also provides an analytical lens through which the Park City Assessment Toolkit can be positioned within the wider ecosystem of global tools.

#### a) Typologies Based on Data and Assessment Logic

When examining how data are collected, processed, and fed into evaluation systems, four primary types of urban assessment tools and frameworks can be identified.

- Policy/Guideline-Based Frameworks
- Indicator-Based Frameworks (Composite Indices / Monitoring Sets)
- Assessment & Scoring Tools (Qualitative + Quantitative Diagnosis Tools)
- Modelling & Valuation Tools

**Type 1 : Policy/Guideline-Based Frameworks**

Policy- or guideline-based frameworks provide overarching principles, strategic objectives, or recommended indicator domains to guide urban policy design and long-term vision-setting. Rather than functioning as operational monitoring systems, these frameworks emphasize normative alignment, institutional coherence, and strategic direction.

**Strengths:**

- Support policy alignment and institutional capacity-building
- Highly flexible and adaptable to diverse governance and planning contexts
- Encourage long-term, systemic and cross-sectoral thinking

**Limitations:**

- Limited operational value unless paired with implementation or monitoring tools
- Progress is difficult to track quantitatively
- Interpretations may vary significantly across cities and regions

These frameworks often serve as reference architectures within global agendas, shaping the conceptual boundaries of subsequent indicator-based or operational tools.

**Type 2: Indicator-Based Frameworks (Composite Indices / Monitoring Sets)**

Indicator-based frameworks use defined sets of quantitative and/or qualitative indicators to monitor urban performance, support benchmarking, and inform evidence-based decision-making. Many of these frameworks aggregate indicators into composite indices to summarise complex, multidimensional phenomena.

**Strengths:**

- Enable consistent and comparable measurement over time and across geographies
- Facilitate benchmarking and progress tracking
- Frequently aligned with international frameworks such as the SDGs and the New Urban Agenda

**Limitations:**

- Risk being overly general if insufficiently localized
- Data collection can be resource-intensive, particularly for data-constrained cities
- Often lack direct policy application mechanisms unless linked to action-oriented tools

This typology dominates global urban monitoring practice and forms the backbone of many international reporting systems.

**Type 3: Assessment & Scoring Tools (Qualitative + Quantitative Diagnosis Tools)**

Assessment and scoring tools apply structured evaluation methods—such as scorecards, rating systems, or self-assessments—that combine quantitative indicators with qualitative judgment. These tools are frequently used for internal diagnostics, capacity-building, and stakeholder engagement.

**Strengths:**

- Practical and accessible for cities with limited data availability
- Often participatory and tailored to local priorities
- Encourage interdepartmental coordination and dialogue

**Limitations:**

- Susceptible to subjectivity, particularly in self-assessment processes
- Limited comparability across cities
- Outcomes depend heavily on facilitation quality and institutional capacity

Such tools are especially valuable in early-stage assessments or as complements to more data-intensive frameworks.

**Type 4: Modelling & Valuation Tools**

Modelling and valuation tools simulate urban systems or estimate the economic, social, or ecological value of interventions using approaches

such as spatial modelling, ecosystem service valuation, or cost–benefit analysis. These tools are commonly applied in scenario planning and strategic foresight.

**Strengths:**

- Enable visualization of future impacts and trade-offs
- Support scenario analysis and policy simulation
- Integrate multiple data types across sectors and scales

**Limitations:**

- Technically complex and data-intensive
- Require specialized expertise and training
- Highly sensitive to assumptions and input data quality

While analytically powerful, these tools are typically deployed selectively rather than as routine monitoring instruments.

## b) Typologies of Outputs and Decision-Support Functions

In addition to differences in assessment logic, urban evaluation tools can be distinguished by the type of outputs they generate and the roles these outputs play in planning, monitoring, and decision-making processes. Five common output typologies are identified:

- Diagnostic Profile with decision-making suggestions
- Benchmarking report (with baseline diagnosis and comparison among cities)
- Ranking (Rating System)
- Certification System (Verification)
- Reporting/Data Platform

**Type 1 : Diagnostic Profiles with Decision-Making Guidance**

Diagnostic profiles present structured assessments of city performance across thematic areas, combining indicators with narrative analysis, expert interpretation, and stakeholder input. Outputs focus on identifying strengths, weaknesses, and priority intervention areas, often accompanied by context-specific recommendations.

**Strengths**

- Highly context-sensitive and actionable
- Support institutional learning and capacity development
- Well suited for strategic planning and early diagnostics

**Limitations**

- Limited comparability across cities
- Often lack standardized metrics
- Heavily dependent on facilitation quality and stakeholder engagement

**Type 2: Benchmarking Reports**

Benchmarking reports use standardized indicators to compare city performance against baselines or peer cities. They often include historical trends and highlight good practices, supporting learning and performance improvement.

**Strengths:**

- Encourage peer learning and constructive competition
- Support target-setting and progress monitoring
- Useful for identifying systemic gaps and trends

**Limitations:**

- Risk of oversimplification
- Contextual differences may distort comparisons
- Require reliable and standardized data systems

**Type 3: Ranking and Rating Systems**

Ranking systems aggregate weighted indicators into simplified outputs such as scores, grades, or league tables. Their strength lies in clarity and communicability, making them influential for advocacy and public discourse.

**Strengths:**

- Easy to communicate and widely understood
- Raises visibility and accountability
- Can motivate political and institutional action

**Limitations:**

- Oversimplifies complex urban realities
- May encourage data manipulation or “gaming”
- Often lacks contextual nuance

**Type 4: Certification Systems**

Certification systems assess cities or initiatives against predefined standards through structured documentation and third-party verification. They often provide tiered recognition and may be linked to incentives or funding.

**Strengths:**

- High credibility through external verification
- Clear performance benchmarks and guidance
- Can drive sustained improvement

**Limitations:**

- Resource-intensive and administratively demanding
- May prioritize compliance over innovation
- Less accessible to smaller or resource-constrained cities

**Type 5: Reporting and Data Platforms**

Reporting and data platforms function as digital systems for data collection, visualization, and dissemination. They support monitoring, reporting, and verification (MRV) and often provide dashboards and open-access datasets.

**Strengths:**

- Promote transparency and open data use
- Enable spatial and temporal analysis

- Allow comparison, filtering, and data export

**Limitations:**

- Effectiveness depends on data quality and interoperability
- Often provide limited policy guidance
- May overwhelm users without adequate interpretation support

Together, these typologies inform the analytical framework used in this study to compare global urban assessment tools and to evaluate the positioning and future development pathways of the assessment toolkits. By distinguishing between assessment logics and output functions, the study is able to identify complementarities, gaps, and opportunities for integration across tools, supporting the development of a more adaptable, actionable, and globally relevant urban assessment approach.

## 3.2 Key features

### 3.2.1 Thematic focus Analysis

Sankey Diagram shows that different frameworks serve different goals but often overlap in sustainable urban development. Detailed conclusions are as below:

- **Evaluation frameworks** are the most common, especially in areas like green development and biodiversity.
- **Scorecards and assessments** focus more on urban resilience and risk prevention, such as disaster and emergency planning.
- **Standards** are mainly used in finance and economy, with keywords like investment, ESG, and taxonomy.
- **Common keywords** across all types include sustainability, resilience, and governance, showing shared global priorities.
- **Indexes** often relate to urban life quality, such as access to services, transport, and equity.

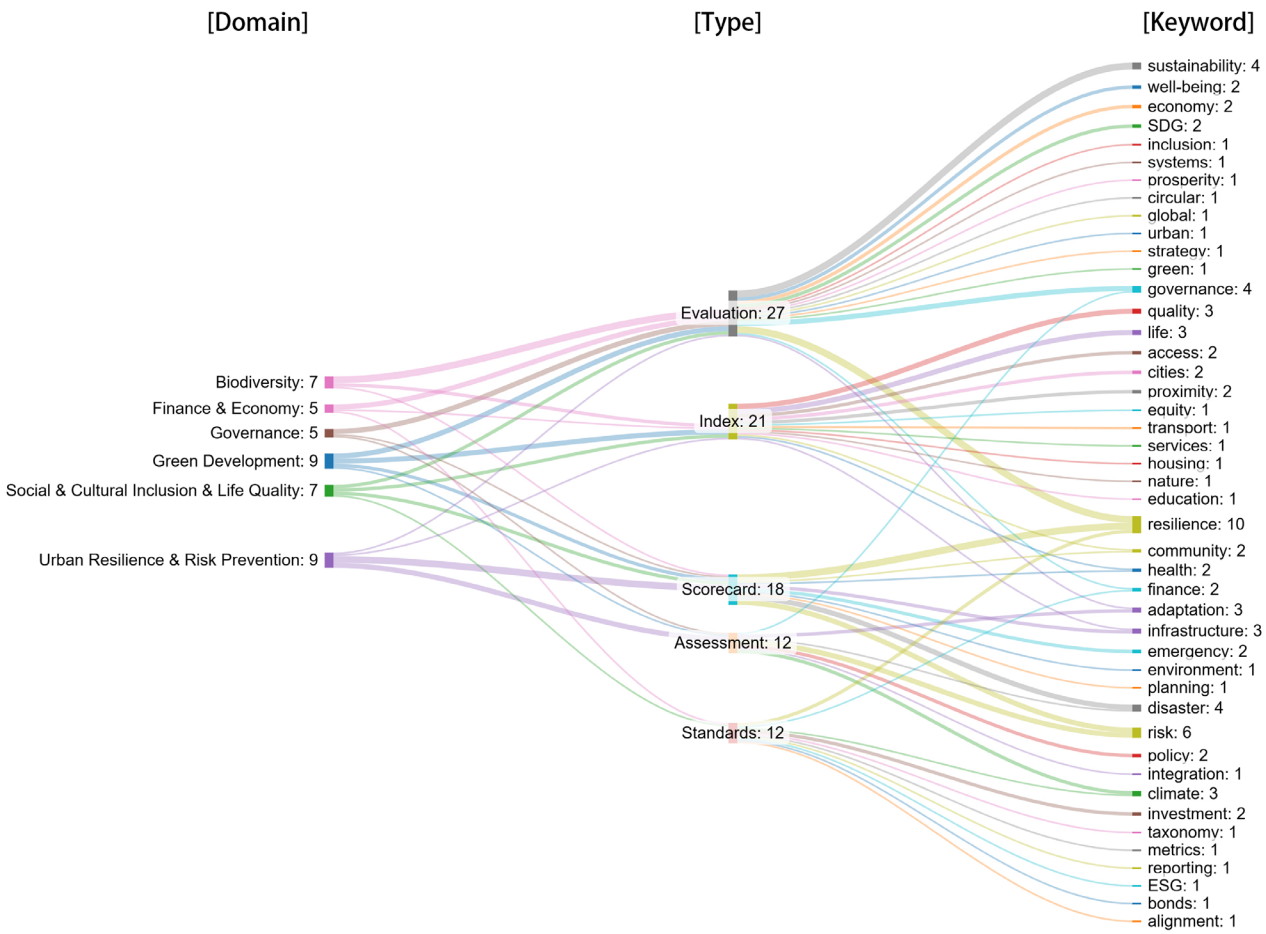



Figure: Thematic focus Analysis
(Source: Drawn by the project team)

### 3.2.2 Scale Analysis

Based on the scale analysis diagram, a multi-scalar structure is as below:

- **The city/metropolitan level** hosts the most diverse and densely populated cluster of frameworks, addressing themes from biodiversity and climate mitigation to resilience and quality of life. These tools enable strategic planning and monitoring at the urban scale, where most sustainability interventions are implemented.
- **At the national level**, frameworks focus on macro-level sustainability and economic-environmental performance. These tend to provide high-level policy guidance rather than localized planning tools.
- Fewer frameworks exist at the **neighborhood/site level**. The only framework, Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) is focused on detailed spatial and ecosystem planning, particularly suited for design and infrastructure at a small scale.

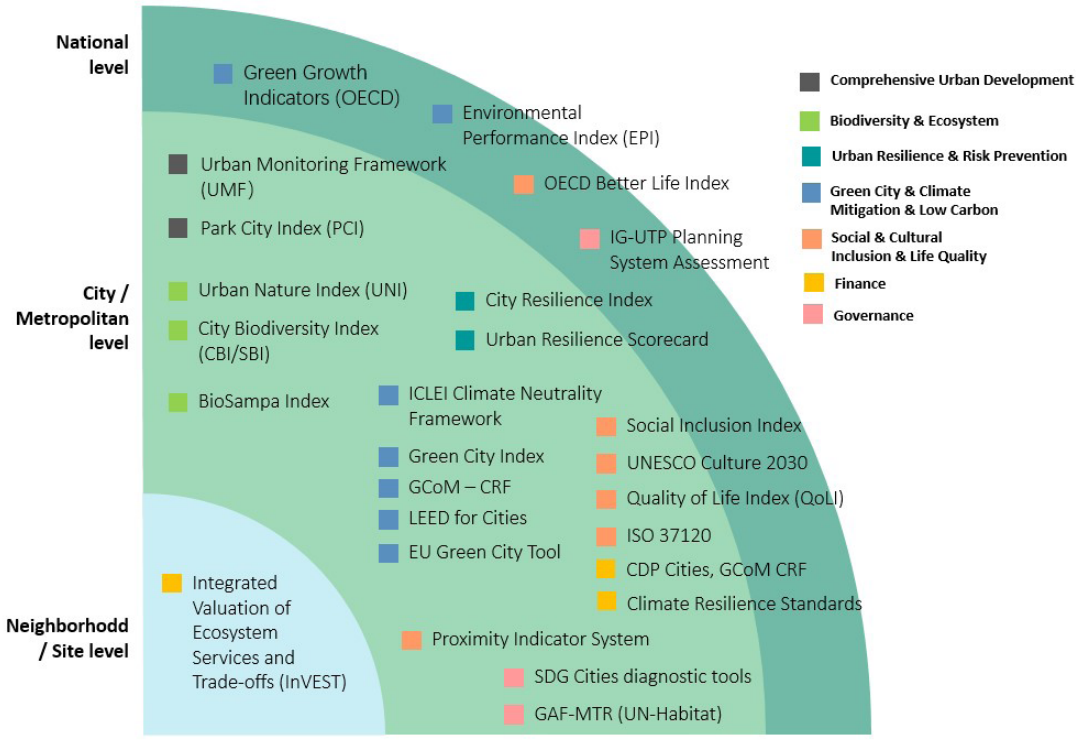



Figure: Scale Analysis
(Source: Drawn by the project team)

### 3.2.3 Geographical focus Analysis

Bubble diagram shows that the majority of urban development frameworks (23 out of 32) are designed for global application, reflecting a growing emphasis on creating standardized tools that can be applied across diverse cultural, environmental, and governance contexts. These global frameworks—such as the Urban Monitoring Framework, City Resilience Index, and OECD Better Life Index—are often developed by international organizations or research consortia aiming to provide comparable benchmarks for cities worldwide.

A smaller proportion (6 frameworks) remain **region-specific,** such as the Park City Index (China) or the EU Green City Tool (European Union). These frameworks typically address region-specific policy priorities, regulatory contexts, or environmental conditions, which may limit their direct applicability elsewhere.

Three frameworks—originally developed for specific regions (e.g., EU, USA, Singapore)—have successfully evolved into globally relevant tools, often through iterative adaptation, international collaboration, and the recognition of their methodological robustness.

This distribution underscores two key trends:

- Global standardization is increasingly prioritized to support international benchmarking, SDG alignment, and knowledge transfer.
- Regional frameworks still play a vital role in addressing localized challenges, offering tailored approaches that global tools may overlook.

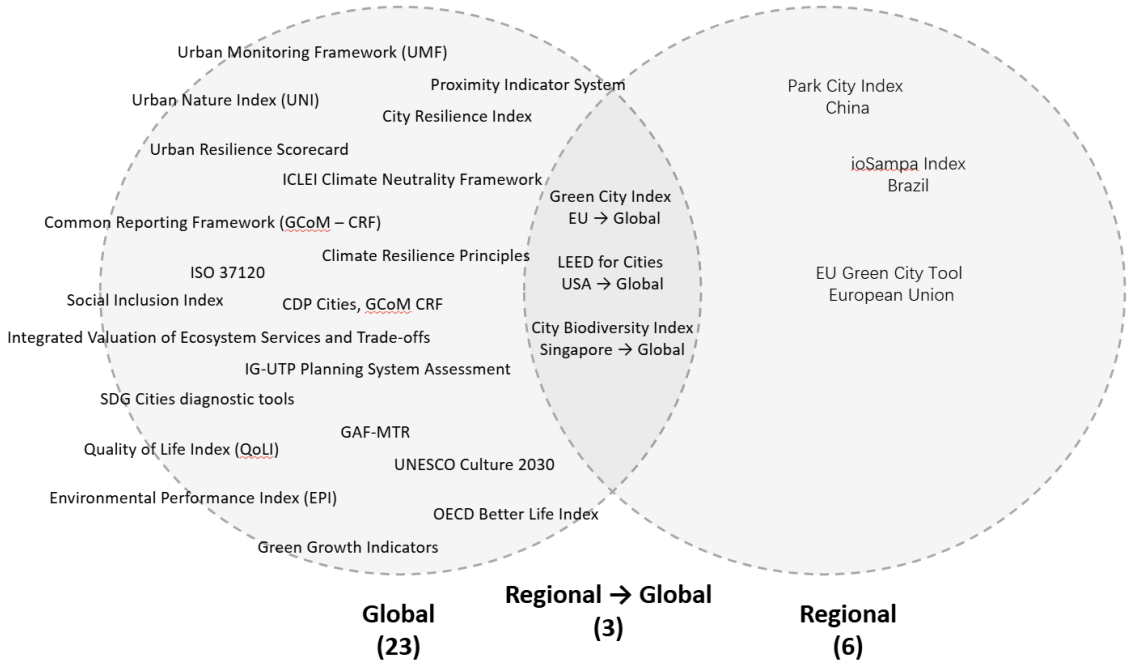



Figure: Geographical focus Analysis
(Source: Drawn by the project team)

### 3.2.4 Target Users

The pie chart shows the diversity of target users for urban sustainability frameworks.
The most prominent user group is city governments (18%), followed by researchers (11%), national governments (10%), city planners (10%), and local governments (10%), which means the frameworks have strong alignment with public sector and urban policy.

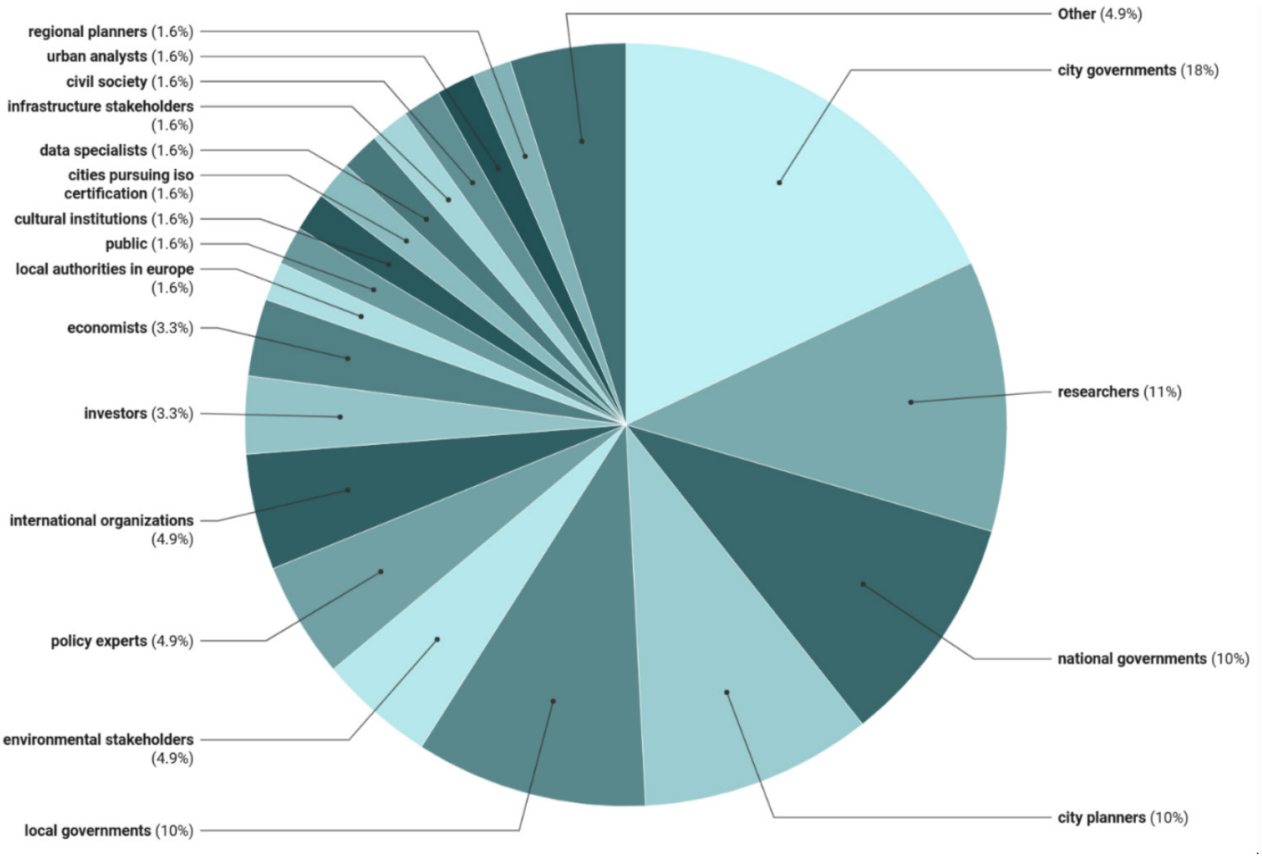



Figure: Target Users
(Source: Drawn by the project team)

### 3.2.5 Data Intensity Analysis

#### Data Intensity Scale

| Level | Definition | Typical Requirements |
|---|---|---|
| Low (1-2) | Can be used with minimal data, mostly qualitative or coarse spatial data | - Expert judgment |
| | | - Self-evaluation/Stakeholder interviews |
| | | - Manual inputs |
| Medium (3-4) | Requires some quantitative or spatial data, but manageable for most users with local data access | - National statistics |
| | | - City-level/Municipal department statistics |
| | | - Open-source datasets (e.g. UN Agencies' datasets, Academic Data Platform, Global Reports) |
| | | - Open-source GIS data (e.g., rainfall, elevation, land use) |
| High 5 | Requires detailed, high-resolution, or site-specific data, often from specialized sources | - Remote sensing, monitoring stations |
| | | - Modelling datasets or field investigation statistics |

#### Urban Sustainability, Biodiversity & Ecosystem, Urban Resilience & Risk Prevention

| Level | Typical Requirements | Urban Monitoring Framework (UMF) | Park City Index (PCI) | Urban Nature Index (UNI) | City Biodiversity Index (CBI/ SBI) | BioSampa Index | City Resilience Index | Urban Resilience Scorecard for Cities |
|---|---|---|---|---|---|---|---|---|
| Low (1-2) | - Expert judgment | | | | | | | |
| | - Self-evaluation/ Stakeholder interviews | | | | | | | |
| | - Manual inputs | | | | | | | |
| Medium (3-4) | - National statistics | √ | √ | √ | | | | |
| | - City-level/ Municipal department statistics | | √ | √ | √ | √ | √ | √ |
| | - Open-source datasets (e.g. UN Agencies' datasets, Academic Data Platform, Global Reports) | √ | | √ | | | √ | √ |
| | - Open-source GIS data (e.g., rainfall, elevation, land use) | | | | √ | | | √ |
| High 5 | - Remote sensing, monitoring stations | | | | | | | |
| | - Modeling datasets or field investigation statistics | | | | | | | |

### Green City & Climate Mitigation & Low Carbon

| Level | Typical Requirements | ICLEI Climate Neutrality Framewor | Green City Index | GCoM – CRF (Common Reporting Framework | Green Growth Indicators (OECD) | LEED for Cities | Environmental Performance Index (EPI) | EU Green City Tool |
|---|---|---|---|---|---|---|---|---|
| Low (1-2) | - Expert judgment | | | | | √ | | |
| | - Self-evaluation/ Stakeholder interviews | | | | | √ | | |
| | - Manual inputs | | | | | √ | | |
| Medium (3-4) | - National statistics | | √ | √ | √ | | √ | √ |
| | - City-level/Municipal department statistics | | | | | √ | | √ |
| | - Open-source datasets (e.g. UN Agencies' datasets, Academic Data Platform, Global Reports) | | √ | | √ | | √ | √ |
| | - Open-source GIS data (e.g., rainfall, elevation, land use) | | | | | √ | √ | |
| High 5 | - Remote sensing, monitoring stations | | | | | | √ | |
| | - Modeling datasets or field investigation statistics | | | | | | √ | |

### Social & Cultural Inclusion & Life Quality

| Level | Typical Requirements | OECD Better Life Index | Proximity Indicator System | Social Inclusion Index | UNESCO Culture 2030 | Quality of Life Index (QoLI) | ISO 37120 |
|---|---|---|---|---|---|---|---|
| Low (1-2) | - Expert judgment | √ | √ | | √ | | √ |
| | - Self-evaluation/ Stakeholder interviews | √ | | | √ | √ | |
| | - Manual inputs | | | | | | √ |
| Medium (3-4) | - National statistics | | | √ | √ | √ | |
| | - City-level/Municipal department statistics | | √ | | | √ | |
| | - Open-source datasets (e.g. UN Agencies' datasets, Academic Data Platform, Global Reports) | √ | | √ | √ | √ | |
| | - Open-source GIS data (e.g., rainfall, elevation, land use) | | √ | | | | |
| High 5 | - Remote sensing, monitoring stations | | | | | | |
| | - Modeling datasets or field investigation statistics | | √ | | | | |

**Finance & Governance**

| Level | Typical Requirements | Climate Bonds Resilience Methodology (2024) | CDP Cities, GCoM CRF | Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) | IG-UTP – Planning System Assessment | SDG Cities Diagnostic Tools | GAF-MTR |
|---|---|---|---|---|---|---|---|
| Low (1-2) | - Expert judgment | | | | √ | √ | |
| | - Self-evaluation/ Stakeholder interviews | | | | √ | √ | √ |
| | - Manual inputs | | | | | | |
| Medium (3-4) | - National statistics | √ | √ | | | √ | |
| | - City-level/Municipal department statistics | | | | | | |
| | - Open-source datasets (e.g. UN Agencies' datasets, Academic Data Platform, Global Reports) | √ | | | | | |
| | - Open-source GIS data (e.g., rainfall, elevation, land use) | | | √ | | | |
| High 5 | - Remote sensing, monitoring stations | | | √ | | | |
| | - Modeling datasets or field investigation statistics | | | √ | | | |

Analysis shows that most frameworks operate at medium intensity, relying on national statistics, municipal data, and open-source datasets, while a smaller number demand high-resolution or field-specific data. Quantitative indicator-based tools dominate, with fewer qualitative or mixed-method frameworks, reflecting a general preference for measurable, data-driven approaches in global urban monitoring.

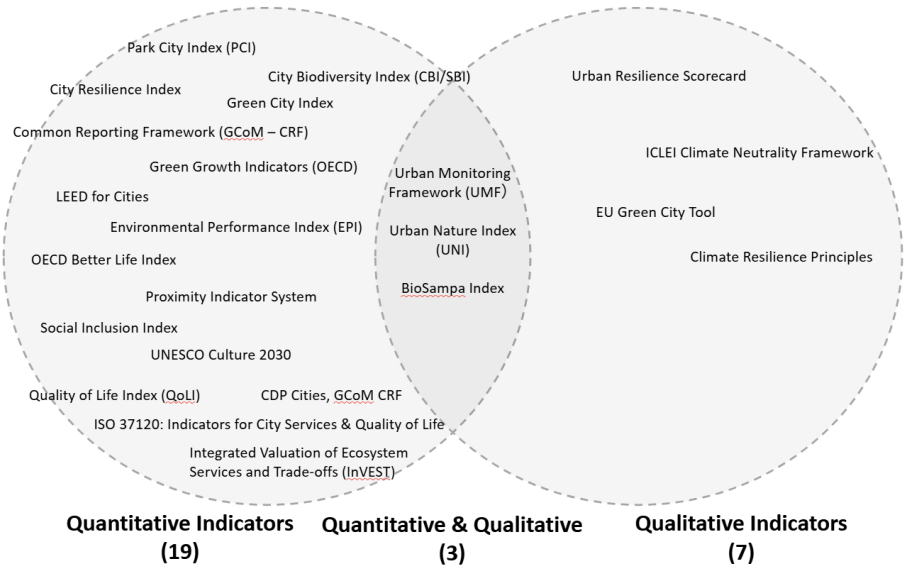



Figure: Data Intensity Analysis
(Source: Drawn by the project team)

### 3.2.6 Approach Analysis

#### Type of Methodology

Most frameworks (over 12) are **indicator-based**, reflecting a preference for measurable, data-driven approaches. A smaller portion of frameworks (around 3) use assessment and scoring tools, while an even smaller number utilize policy/guideline-based frameworks and modelling & valuation tools.

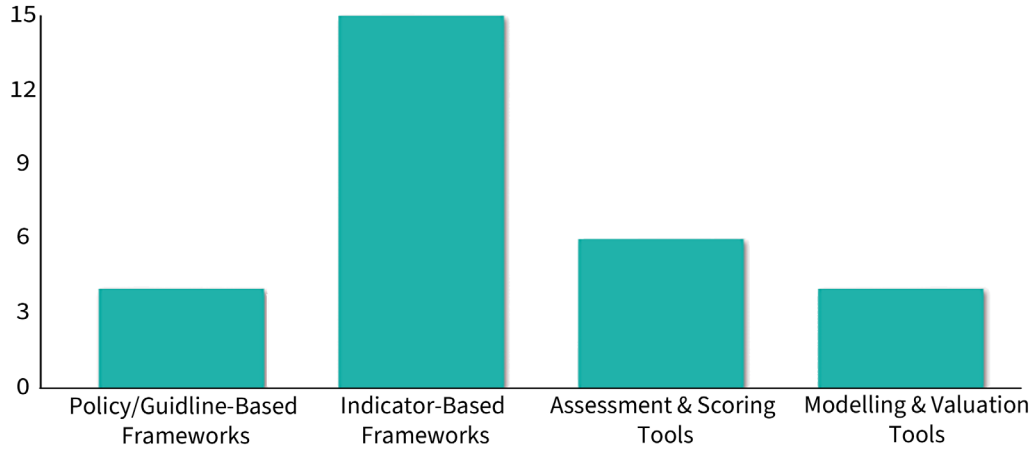



Figure: Type of Methodology
(Source: Drawn by the project team)

#### Urban Sustainability, Biodiversity & Ecosystem, Urban Resilience & Risk Prevention

| Type of Methodology | Urban Monitoring Framework (UMF) | Park City Index (PCI) | Urban Nature Index (UNI) | City Biodiversity Index (CBI/ SBI) | BioSampa Index | City Resilience Index | Urban Resilience Scorecard for Cities |
|---|---|---|---|---|---|---|---|
| Policy/Guideline-Based Frameworks | | | | | | | |
| Indicator-Based Frameworks (Composite Indices / Monitoring Sets) | √ | √ | √ | √ | √ | √ | |
| Assessment & Scoring Tools (Qualitative + Quantitative Diagnosis Tools) | | | | | | | √ |
| Modelling & Valuation Tools | | | | | | | |

### Green City & Climate Mitigation & Low Carbon

| Type of Methodology | ICLEI Climate Neutrality Framework | Green City Index | GCoM – CRF (Common Reporting Framework) | Green Growth Indicators (OECD) | LEED for Cities | Environmental Performance Index (EPI) | EU Green City Tool |
|---|---|---|---|---|---|---|---|
| Policy/Guideline-Based Frameworks | √ | | | | | | |
| Indicator-Based Frameworks (Composite Indices / Monitoring Sets) | | √ | √ | √ | | | √ |
| Assessment & Scoring Tools (Qualitative + Quantitative Diagnosis Tools) | | | | | √ | | |
| Modelling & Valuation Tools | | | | | | √ | |

### Social & Cultural Inclusion & Life Quality

| Type of Methodology | OECD Better Life Index | Proximity Indicator System | Social Inclusion Index | UNESCO Culture 2030 | Quality of Life Index (QoLI) | ISO 37120 |
|---|---|---|---|---|---|---|
| Policy/Guideline-Based Frameworks | | | √ | | √ | |
| Indicator-Based Frameworks (Composite Indices / Monitoring Sets) | √ | | | √ | | |
| Assessment & Scoring Tools (Qualitative + Quantitative Diagnosis Tools) | | √ | | | | √ |
| Modelling & Valuation Tools | | | | | | |

### Finance & Governance

| Type of Methodology | Climate Bonds Resilience Methodology (2024) | CDP Cities, GCoM CRF | Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) | IG-UTP – Planning System Assessment | SDG Cities Diagnostic Tools | GAF-MTR |
|---|---|---|---|---|---|---|
| Policy/Guideline-Based Frameworks | | | | √ | √ | √ |
| Indicator-Based Frameworks (Composite Indices / Monitoring Sets) | | √ | | | | |
| Assessment & Scoring Tools (Qualitative + Quantitative Diagnosis Tools) | √ | | | | | |
| Modelling & Valuation Tools | | | √ | | | |

### Type of Outputs

The most common output is the Benchmarking Report, used by 13 frameworks, reflecting a strong focus on comparison and progress tracking. Diagnostic Profiles and Reporting/Data Platforms follow, showing a focus on analysis and data transparency. Ranking and Certification Systems are less common.

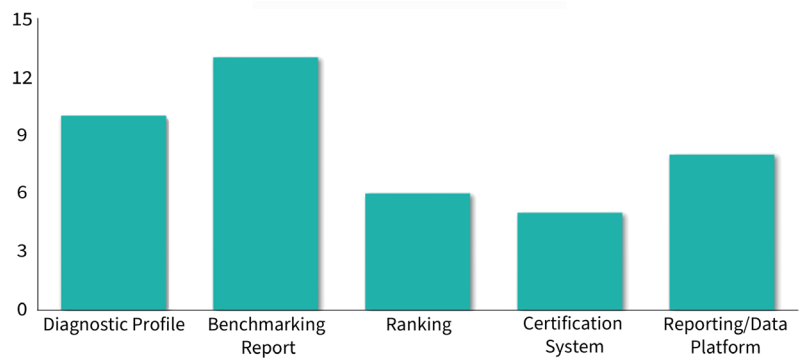



Figure: Type of Outputs
(Source: Drawn by the project team)

### Biodiversity & Urban Resilience & Risk Prevention

| Type of the Outputs | Urbanw Monitoring Framework (UMF) | Park City Index (PCI) | Urban Nature Index (UNI) | City Biodiversity Index (CBI/SBI) | BioSampa Index | City Resilience Index | Urban Resilience Scorecard for Cities |
|---|---|---|---|---|---|---|---|
| Diagnostic Profile with decision-making suggestions | | | | √ | √ | | √ |
| Benchmarking report (with baseline diagnosis and comparison among cities) | | √ | √ | | | √ | |
| Ranking (Rating System) | | | | | | | |
| Certification System (Verification) | | | | | | | |
| Reporting/Data Platform | √ | | | | | | |

### Green Development, Climate Mitigation & Low Carbon

| Type of the Outputs | ICLEI Climate Neutrality Framework | Green City Index | GCoM – CRF (Common Reporting Framework | Green Growth Indicators (OECD) | LEED for Cities | Environmental Performance Index (EPI) | EU Green City Tool |
|---|---|---|---|---|---|---|---|
| Diagnostic Profile with decision-making suggestions | - | | | | | √ | |
| Benchmarking report (with baseline diagnosis and comparison among cities) | - | √ | | | | | √ |
| Ranking (Rating System) | - | √ | √ | √ | | | |
| Certification System (Verification) | - | | | | √ | | |
| Reporting/Data Platform | - | | √ | | | √ | |

### Social & Cultural Inclusion & Life Quality

| Type of the Outputs | OECD Better Life Index | Proximity Indicator System | Social Inclusion Index | UNESCO Culture 2030 | Quality of Life Index (QoLI) | ISO 37120 |
|---|---|---|---|---|---|---|
| Diagnostic Profile with decision-making suggestions | | √ | | | | |
| Benchmarking report (with baseline diagnosis and comparison among cities) | | √ | √ | √ | √ | |
| Ranking (Rating System) | √ | | | | | |
| Certification System (Verification) | | | | | | √ |
| Reporting/Data Platform | | | | | | |

### Finance & Economy

| Type of the Outputs | Climate Bonds Resilience Methodology (2024) | CDP Cities, GCoM CRF | Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) | IG-UTP – Planning System Assessment | SDG Cities Diagnostic Tools | GAF-MTR |
|---|---|---|---|---|---|---|
| Diagnostic Profile with decision-making suggestions | | | √ | | | |
| Benchmarking report (with baseline diagnosis and comparison among cities) | √ | √ | | √ | √ | √ |
| Ranking (Rating System) | | | | | | |
| Certification System (Verification) | | | | | | |
| Reporting/Data Platform | | √ | | | | |

### 3.2.7 Scenario Comparison Analysis

Scenario comparison is a strategic process used to evaluate how different policy choices, development trajectories, or environmental changes might affect a system—such as a city, ecosystem, or watershed—over time. It enables planners and stakeholders to visualize trade-offs, such as balancing economic growth against biodiversity loss, and supports evidence-based decision-making. By exploring the implications of alternative strategies, scenario comparison fosters adaptive and flexible planning. Common applications include tools like InVEST, which compares land-use scenarios (e.g., urban expansion vs. reforestation) to assess impacts on carbon storage or water runoff. In urban planning, it can contrast compact versus sprawling development to evaluate effects on liveability and infrastructure costs. In climate resilience, it is used to assess system performance before and after adaptation measures, helping guide more informed investments and policy responses.

### 3.2.8 Top-Rated Tools by Thematic Focus

Based on an in-depth analysis of the 26 reviewed frameworks and tools and their respective thematic areas, the study identifies six high-performing cases for closer examination. These cases were selected for their relevance to the urban green assessment and their potential to inform indicator design and cross-framework linkages.

The selected indicator systems includes: Urban Nature Index (UNI), LEED for Cities, Proximity Indicator System, Urban Resilience Scorecard, Governance Assessment Framework for Metropolitan Territorial and Regional Management (GAF-MTR), and Climate Resilience Standards.

It is important to note that the GAF-MTR does not include a quantitative indicator system; therefore, the comparative analysis will primarily focus on the remaining five frameworks.

**Biodiversity & Urban Resilience & Risk Prevention**

| Framework / Tool | Publisher | Data Intensity | Measurability | Valuation Output | Spatial Output | Scenario Comparison | Overall Practicality (Avg) |
|---|---|---|---|---|---|---|---|
| Urban Nature Index (UNI) | IUCN | 4 | 5 | 4 | 3 | 2 | 3.6 |
| Toolkit for Ecosystem Service Site-based Assessment (TESSA) | BirdLife International, University of Cambridge | 2 | 3 | 4 | 3 | 5 | 3.4 |
| Singapore Biodiversity Index (CBI / SBI) | Singapore National Park Board | 3 | 4 | 3 | 3 | 3 | 3.2 |
| BioSampa Index | Municipal SVMA of Sao Paulo | 3 | 4 | 3 | 3 | 3 | 3.2 |

### Green Development, Climate Mitigation & Low Carbon

| Framework / Tool | Publisher | Data Intensity | Measurability | Valuation Output | Spatial Output | Scenario Comparison | Overall Practicality (Avg) |
|---|---|---|---|---|---|---|---|
| LEED for Cities | US Green Building Council (USGBC) | 4 | 5 | 4 | 2 | 2 | 3.4 |
| Common Reporting Framework (GCoM – CRF) | Global Covenant of Mayors (GCoM) | 4 | 5 | 4 | 1 | 2 | 3.2 |
| Environmental Performance Index (EPI) | Yale Center for Environmental Law & Policy and CIESIN–Columbia University | 3 | 5 | 4 | 2 | 2 | 3.2 |
| OECD Green Growth Indicators | Organisation for Economic Co-Operation and Development (OECD) | 3 | 5 | 3 | 2 | 2 | 3 |
| ICLEI Climate Neutrality Framework | ICLEI + ACCCRN | 3 | 3 | 3 | 3 | 3 | 3 |
| Green City Index | Siemens + EIU | 3 | 4 | 3 | 3 | 1 | 2.8 |

### Social & Cultural Inclusion & Life Quality

| Framework / Tool | Publisher | Data Intensity | Measurability | Valuation Output | Spatial Output | Scenario Comparison | Overall Practicality (Avg) |
|---|---|---|---|---|---|---|---|
| Proximity Indicator System | IAE Paris Sorbonne Business School (Chaire ETI), C40 Cities, United Cities and Local Governments (UCLG) and UN-Habitat | 3 | 4 | 4 | 2 | 3 | 3.2 |
| OECD Better Life Index | Organisation for Economic Co-Operation and Development (OECD) | 3 | 4 | 3 | 2 | 3 | 3 |
| UNESCO Culture 2030 | UNESCO | 4 | 3 | 4 | 1 | 2 | 2.8 |
| ISO 37120: Indicators for City Services & Quality of Life | International Organization for Standardization (ISO) | 3 | 4 | 3 | 1 | 1 | 2.4 |
| Quality of Life Index | UN-Habitat, UNECA | 3 | 3 | 3 | 1 | 2 | 2.4 |

### Urban Resilience & Risk Prevention

| Framework / Tool | Publisher | Data Intensity | Measurability | Valuation Output | Spatial Output | Scenario Comparison | Overall Practicality (Avg) |
|---|---|---|---|---|---|---|---|
| Urban Resilience Scorecard | UNDRR | 4 | 5 | 3 | 2 | 2 | 3.2 |
| City Resilience Index | Arup + Rockefeller Foundation | 3 | 4 | 3 | 3 | 2 | 3.0 |

### Governance

| Framework / Tool | Publisher | Data Intensity | Measurability | Valuation Output | Spatial Output | Scenario Comparison | Overall Practicality (Avg) |
|---|---|---|---|---|---|---|---|
| Governance Assessment Framework for Metropolitan Territorial and Regional Management (GAF-MTR) | UN-Habitat | 4 | 2 | 3 | 1 | 2 | 2.4 |
| Worldwide Governance Indicators | World Bank | 3 | 3 | 4 | 1 | 1 | 2.4 |

### Finance & Economy

| Framework / Tool | Publisher | Data Intensity | Measurability | Valuation Output | Spatial Output | Scenario Comparison | Overall Practicality (Avg) |
|---|---|---|---|---|---|---|---|
| Climate Resilience Standard | Climate Bonds Initiative | 4 | 5 | 4 | 2 | 4 | 3.8 |
| Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) | Natural Capital Project (Stanford University) | 4 | 4 | 3 | 3 | 4 | 3.6 |
| Common Reporting Framework (GCoM – CRF) | CDP, GCoM | 2 | 4 | 4 | 2 | 4 | 3.2 |

## 3.3 Comparison of Indicators

### 3.3.1 Selection of Benchmark Frameworks

Based on a comprehensive evaluation of **relevance, thematic scope, and methodological robustness**, six benchmark frameworks were selected for in-depth comparative analysis.

**General Urban Development – Urban Monitoring Framework (UMF)**
Developed by UN-Habitat, the Urban Monitoring Framework (UMF) serves as a globally recognized, comprehensive instrument for monitoring urban development. It aligns with the broad scope of the Park City Index by covering social, economic, environmental, cultural, and governance aspects through 78 indicators. Its multidimensional structure supports integrated monitoring of cities' performance toward achieving SDG 11. As a general-purpose framework, UMF enables holistic benchmarking across varied urban functions, making it the most suitable match for the general thematic focus.

**Biodiversity – Urban Nature Index (UNI)**
The Urban Nature Index (UNI) developed by IUCN was selected as the benchmark framework in the biodiversity domain. It provides a systematic approach to assess urban nature through indicators on habitat connectivity, ecosystem condition, and biodiversity mainstreaming. UNI directly supports cities in measuring their progress on ecological resilience and nature-based solutions.

**Green Development, Climate Mitigation & Low Carbon – LEED v4.1 Cities and Communities: Existing Cities**
LEED v4.1 for Cities and Communities established by the USGBC is a framework focused on sustainable infrastructure and climate mitigation. It offers 41 performance-based indicators across domains such as energy use, emissions reduction, water efficiency, and green infrastructure. As a climate-focused framework, LEED supports the transition toward low-carbon, resource-efficient urban systems.

**Social & Cultural Inclusion & Life Quality – Global Proximity Indicator System**
The Global Proximity Indicator System developed by the Global Observatory for Sustainable Proximities focused on the concept of the 15-minute city through 24 indicators. It emphasizes equitable access to essential services, social infrastructure, and community well-being. Its relevance lies in addressing spatial inequality and fostering inclusive urban development—a critical component of just and liveable cities.

**Urban Resilience & Risk Prevention – Urban Resilience Scorecard for Cities**
The Urban Resilience Scorecard developed by UNDRR offers a multi-level assessment of disaster preparedness and adaptive capacity. The selected Level 2: Detailed Assessment includes 110 indicators across 10 essentials, covering areas such as emergency response, infrastructure vulnerability, risk-informed governance, and post-disaster recovery. Its integration into the study enhances the comparative understanding of how cities can withstand and recover from shocks and stresses.

**Governance – No Framework Selected**
Although governance is a critical pillar of urban sustainability, no benchmark framework was selected under this thematic focus because of the conceptual divergence between existing governance-related frameworks and the Park City Index. Most global governance frameworks such as those focused on institutional quality, transparency, or participation, are either too qualitative for semantic comparison or lack indicator-level granularity.

**Finance & Economy – Climate Bonds Resilience Taxonomy Methodology (CBRT)**
The Climate Bonds Resilience Taxonomy Methodology (CBRT) developed by the Climate Bonds Initiative, provides a taxonomy for assessing adaptation and resilience in infrastructure investment. With 65 indicators across 10 subsectors, the framework captures risk identification, system flexibility, and financial governance—key elements in building economic resilience. Positioned within the financial and economic thematic focus, CBRT offers insights into how cities and assets can remain viable under climate pressure, aligning with the Park City Index's financial risk management and sustainable investment priorities.

### 3.3.2 Semantic Similarity Matrices

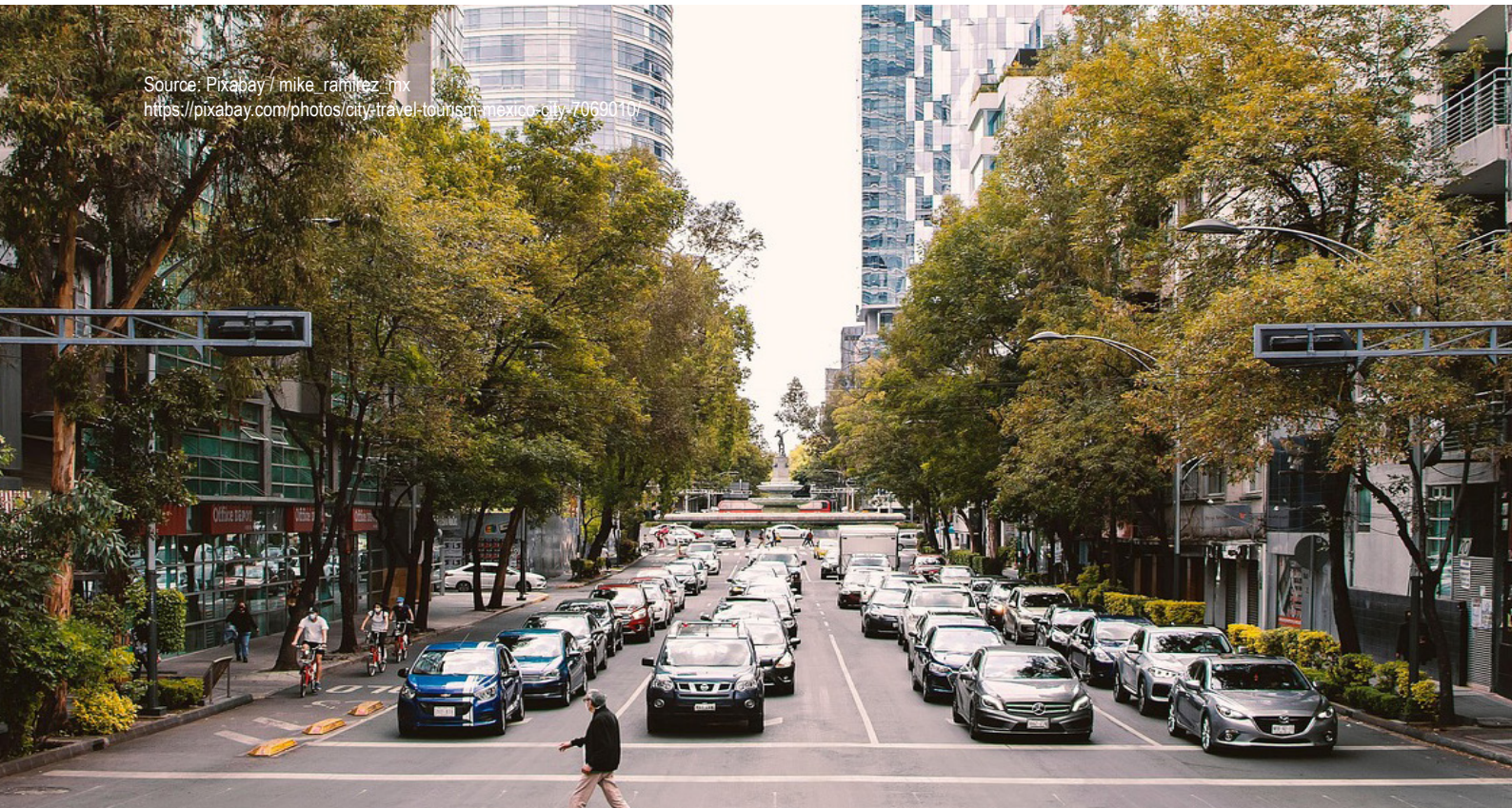
To systematically compare the six selected frameworks with the values and components of Park City development model, six semantic similarity matrices were constructed. Each matrix maps the relationship between indicators from Park City and indicators from a thematic benchmark framework (UMF, UNI, LEED, GPIS, URS, CBRT). Columns represent Park City indicators and rows represent indicators from the benchmark framework.

TF-IDF (Term Frequency–Inverse Document Frequency) model was applied to vectorize the definitions and formulas of indicators across the two frameworks. This method quantifies the importance of terms within an indicator relative to the full texts, allowing us to focus on meaningful language features rather than common words. Once vectorized, Cosine Similarity was used to calculate the semantic closeness between each Park City indicator and each benchmark indicator. The resulting scores range from 0 (no semantic overlap) to 1 (perfect semantic match), producing a normalized similarity matrix for each comparison.

Score range: Across all matrices, semantic similarity scores span from 0.00 to 0.86, indicating varied levels of conceptual alignment.

Average match rate (mean similarity): UMF: 0.42; UNI: 0.46; LEED: 0.39; GPIS: 0.48; URS: 0.43; CBRT: 0.37.

Higher match rates were typically observed in areas related to urban liveability, public space, and ecological function, while lower scores were concentrated in disaster management and finance.



Source: Pixabay / mike_ramirez_mx
https://pixabay.com/photos/city-travel-tourism-mexico-city-7069010/

### 3.3.3 Heatmap visualization and Interpretation

**Urban Monitoring Framework (UMF)**

The semantic similarity heatmap comparing the Park City Index (PCI) and the Urban Monitoring Framework (UMF) reveals areas of both convergence and divergence.

Strong thematic alignment is observed in public service delivery (water, sanitation, health, transport) and environmental indicators (air quality and access to green space).

Partial convergence exists in social domains, including education, housing, and urban safety.

Limited alignment is found in economic indicators, reflecting differing conceptual priorities: the Park City Index emphasizes spatial quality and service-oriented outcomes, while the UMF adopts a broader SDG-based governance and economic perspective.

Overall, the two frameworks are complementary rather than directly comparable at the indicator level. Their broad scope results in dispersed thematic overlaps rather than tight, one-to-one alignment.

Clearer patterns of similarity and divergence emerge when the Park City Index is compared with more thematically focused benchmark tools.

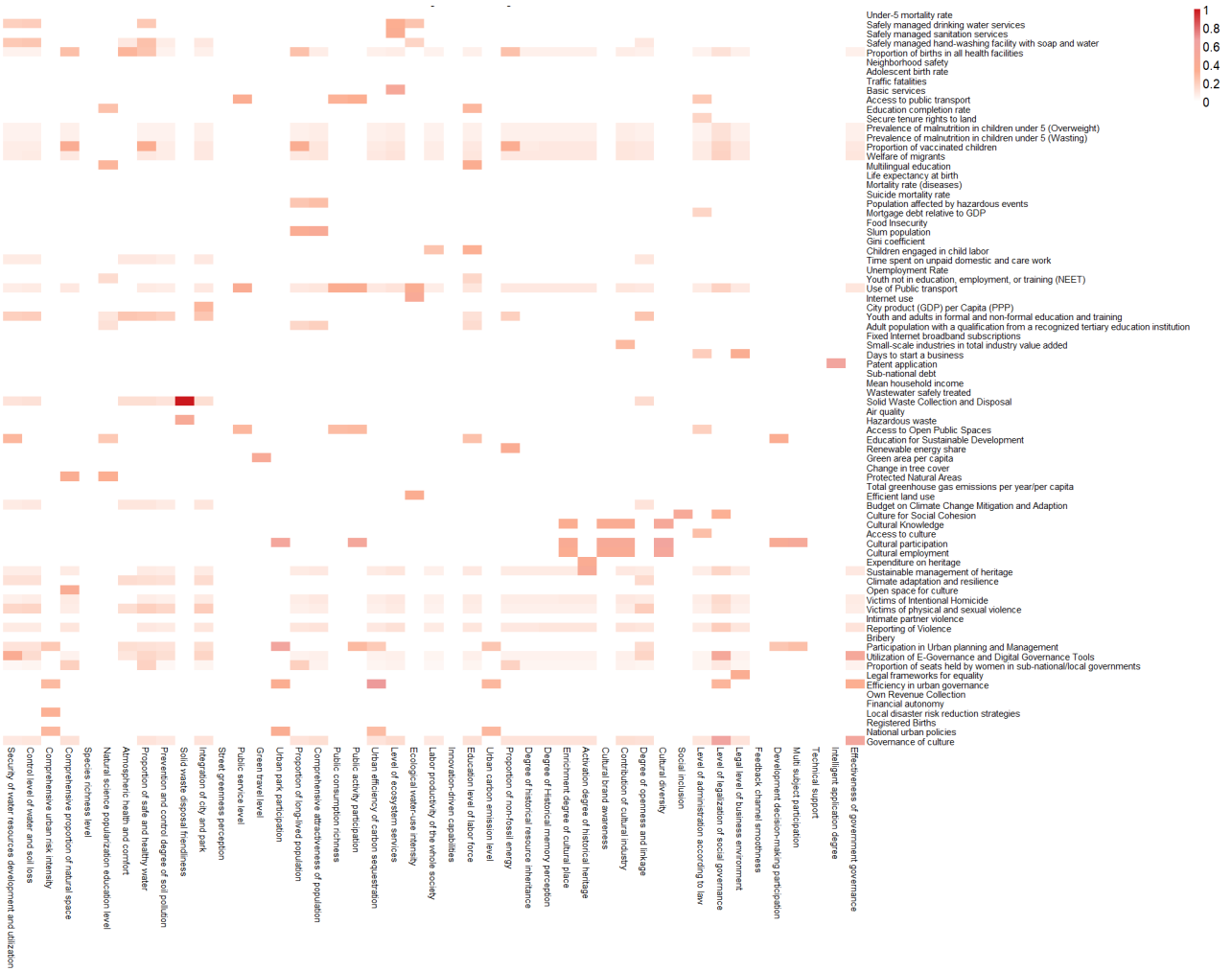



Figure: Semantic Similarity Heatmap: Park City vs UMF
(Source: Drawn by the project team)

**Urban Nature Index (UNI)**

Semantic Similarity Heatmap between the Park City Index and the Urban Nature Index (UNI) shows a high overall semantic similarity.
High overall thematic alignment: Strong semantic similarity across indicators related to green space, biodiversity, land use, environmental quality, and exposure to nature.
Shared focus on urban ecology and sustainability: Both frameworks emphasize planning, management, and equitable access to urban nature.
Limited overlap in species-level biodiversity: Park City Index places less emphasis on biocentric metrics compared to UNI.
Complementary frameworks: The alignment highlights potential for integration, particularly in areas of environmental planning and urban nature accessibility.

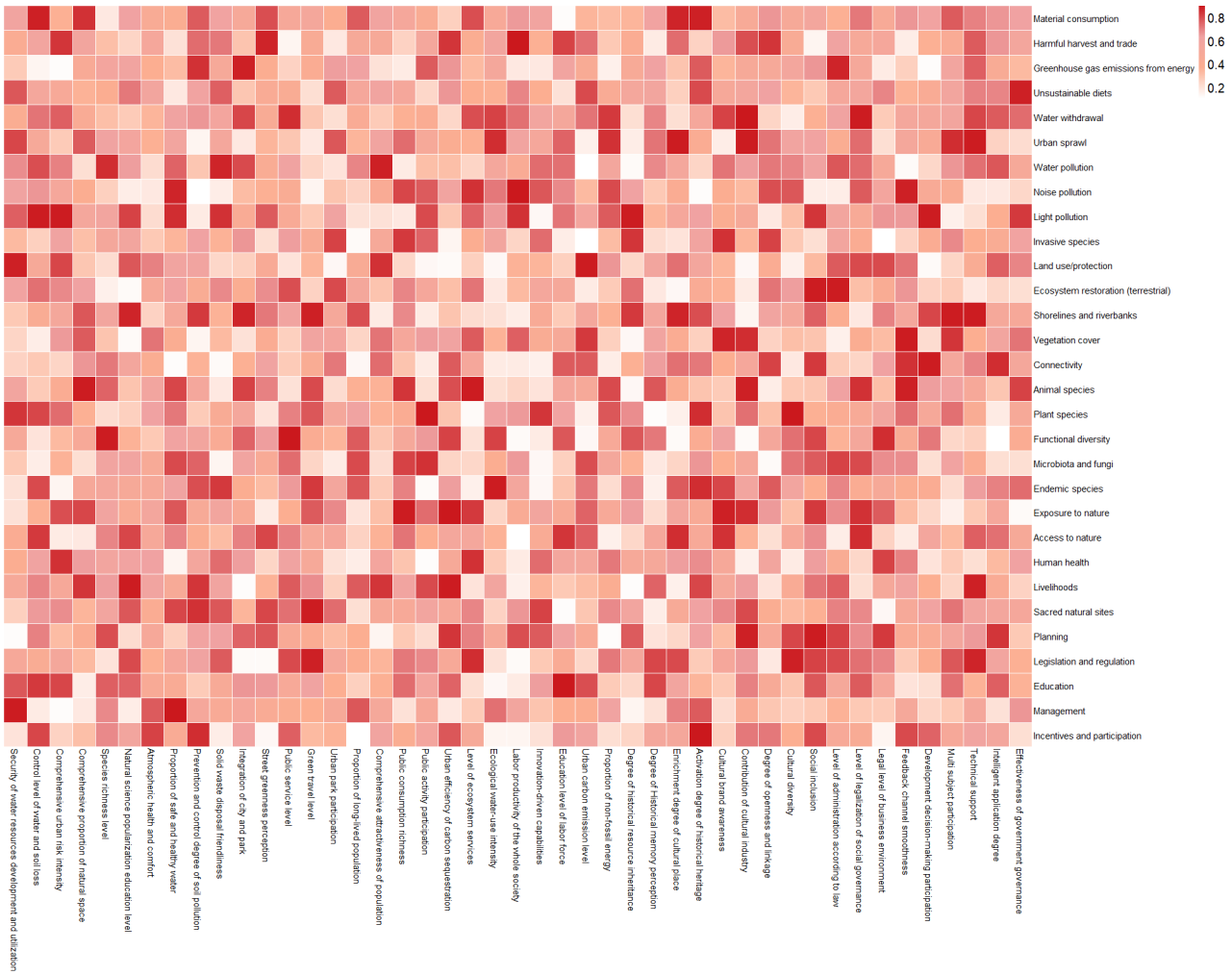
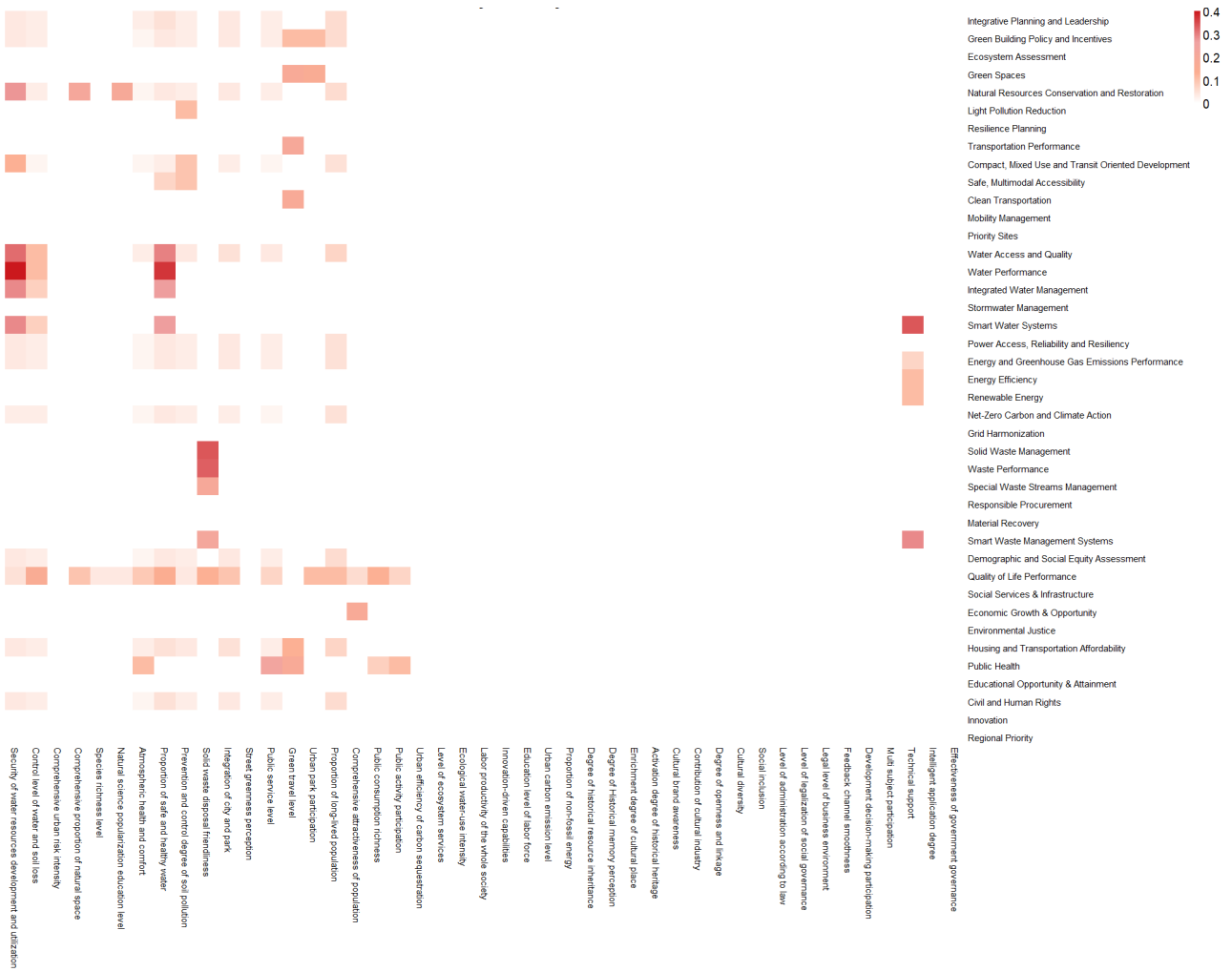



Figure: Semantic Similarity Heatmap: ParkCity vs UNI
(Source: Drawn by the project team)

**LEED for Cities and Communities: Existing Cities**

According to the Semantic Similarity Heatmap between the Park City Index and the LEED for Cities and Communities: Existing Cities, frameworks converge on environmental performance but diverge on broader urban wellbeing.

Moderate overall alignment: Semantic similarity indicates convergence in environmental and infrastructural dimensions.
Strong correlations: Observed in Park City Index directions on direction1 safety and resilience, direction 3 environment health, direction 4 city & park integration, direction 5 green life, and direction 6 popularity and vitality from Park City Index.
Shared focus: Both frameworks emphasize sustainability, climate mitigation, and urban liveability.
Weaker alignment: Social inclusiveness, cultural indicators, and governance show limited overlap, reflecting LEED's narrower thematic scope.
Complementary insights: Alignment is strongest in environmental performance, while broader urban wellbeing dimensions remain distinctive to Park City Index.




Semantic Similarity Heatmap: ParkCity vs LEED
(Source: Drawn by the project team)

**Global Proximity Indicator System**

According to the Semantic Similarity Heatmap between the Park City Index and the Global Proximity Indicator System, the two frameworks strongly align on spatial and social dimensions of urban wellbeing.

High conceptual alignment: Strong correlations in Park City directions on safety and resilience, natural symbiosis, environmental health, city–park integration, green life, and popularity/vitality.
Shared focus: Both frameworks emphasize human-centred urban planning, spatial equity, and access to essential services.
Thematic complementarity: GPIS prioritizes spatial analysis (proximity to healthcare, education, green spaces, mobility), while Park City captures governance and economic structures.
Overall insight: Frameworks strongly converge on spatial and social dimensions of urban wellbeing, highlighting complementary strengths for integrated assessment.

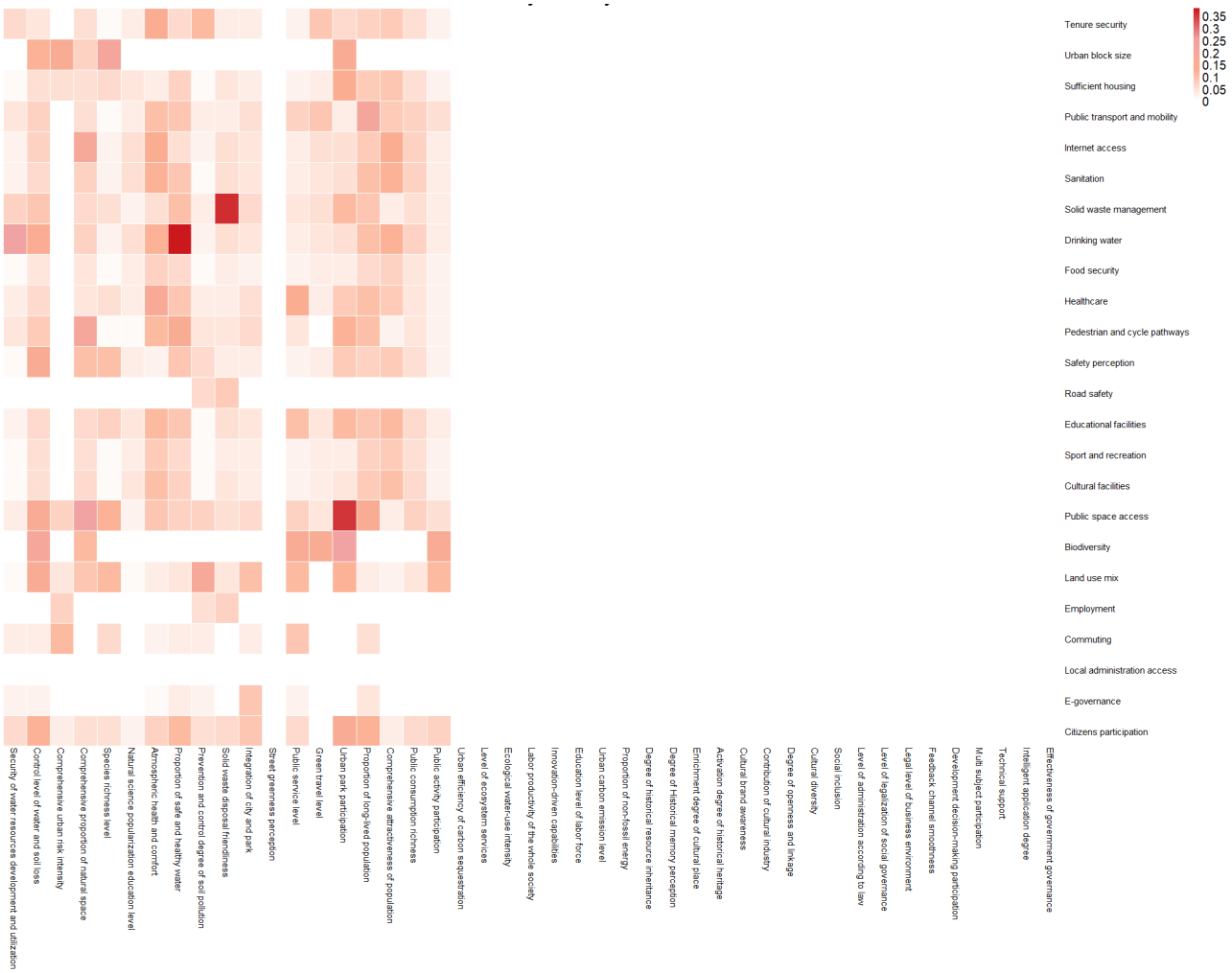



Figure: Semantic Similarity Heatmap: ParkCity vs GPIS
(Source: Drawn by the project team)

**Urban Resilience Scorecard for Cities (URS)**

Semantic Similarity Heatmap between the Park City Index and the Urban Resilience Scorecard for Cities (URS) shows a moderate semantic similarity.

Moderate semantic similarity: Alignment is strongest in infrastructure resilience, risk preparedness, and community participation.

Shared focus areas: Park City indicators on public utility resilience, environmental risk, and social participation overlap with URS metrics on disaster readiness, emergency planning, and community engagement.

Differences in depth: URS addresses specialized areas such as contingency funding, insurance coverage, sector-specific vulnerabilities, and recovery logistics, which Park City does not detail.

Overall insight: Park City integrates resilience within broader sustainable urban development, while URS provides a more operationally focused framework for cities prioritizing risk governance and disaster preparedness.


Figure: Semantic Similarity Heatmap: Park City vs URS
(Source: Drawn by the project team)

**Climate Bonds Resilience Taxonomy (CBRT)**

Semantic Similarity Heatmap between the Park City Index and the Climate Bonds Resilience Taxonomy (CBRT) shows limited overall alignment, with sparse moderate-to-low similarity across selected indicators.

Areas of intersection: Park City indicators on urban infrastructure—such as building codes, environmental quality, and public facilities—partially align with CBRT sectors like construction, waste management, and urban systems planning.

Differences in focus: CBRT targets climate resilience in specific industries, including mining, banking, and insurance, while Park City emphasizes spatial and urban-system dimensions rather than sector-specific capacities.

Overall insight: Park City and CBRT have distinct orientations; CBRT is sector-focused, whereas Park City is spatially and service-oriented, limiting direct comparability.

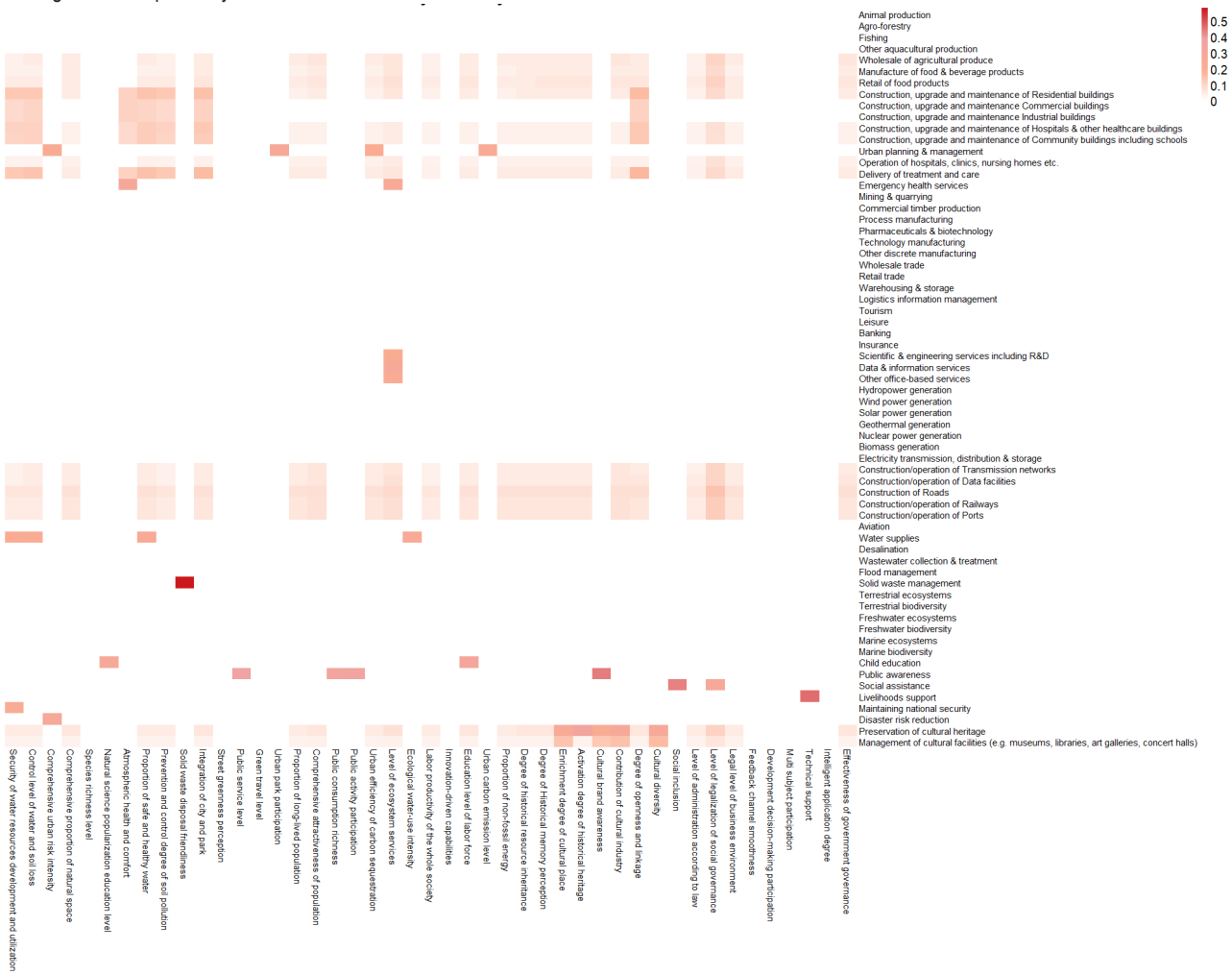



Figure: Semantic Similarity Heatmap: Park City vs CBRT
(Source: Drawn by the project team)

### 3.3.4 Indicator matching

To assess semantic and structural alignment, manual indicator-level matching was performed between the Park City Index and the bench frameworks. The process included:

- Extracting and reviewing the formal definitions and formulas of each indicator.
- Grouping bench framework indicators under relevant Park City "Directions" (themes), based on conceptual relevance and definitional compatibility.
- Allowing multiple mappings where a single global indicator was relevant to more than one Park City direction.
- Excluding indicators where no conceptual overlap or methodological comparability existed.

Visualization table and Conclusions

Park City Index shares strong alignment with most frameworks in the following domains:

- Water and sanitation (Indicators 1, 2, 8): Overlaps with Urban Monitoring Framework, LEED, and Urban Resilience Scorecard.
- Green infrastructure and biodiversity (Indicators 4, 5, 6, 22): Overlaps with Urban Nature Index and Climate Bonds.
- Public services and mobility (Indicators 12, 14, 15): Overlaps with UMF, LEED, and Global Proximity Indicators.
- Cultural and governance dimensions (Indicators 30–34, 41–45): Overlaps with LEED, UMF, and Urban Resilience Scorecard.

Some Park City Index indicators are less represented in the benchmark frameworks:

- Solid waste user-friendliness (Indicator 9)
- Transmission of historic resources (Indicator 28)
- Cultural openness and aesthetic values (Indicators 35–36)
- Barriers to human capital flow and social productivity (Indicators 20, 25)

| Park City Indicators | Urban Monitoring Framework | Urban Nature INdex | LEED for Cities | Urban Resilience Scorecard for Cities | Global Proximity Indicator System | Climate Bonds Resilience Taxonomy Methodology |
|---|---|---|---|---|---|---|
| Indicator 1: Security of water resources development and utilization | | 1.5 Water withdrawal<br>2.2 Water pollution | Water Access and Quality<br>Water Performance<br>Integrated Water Management<br>Smart Water Systems | 1.2.3 - City resources for managing organisation, co-ordination and participation | | Water supplies |
| Indicator 2: Soil and water conservation rate | | | | | | |
| Indicator 3: Integrated urban risk intensity | 1.3.4 Population affected by hazardous events<br>3.1.3. Air quality | | | 2.2.2 - Damage and loss estimation<br>3.3.1 - Domestic insurance coverage<br>3.3.2 - Non-domestic insurance coverage<br>4.1.2 - Economic activity at risk<br>4.3.1 - Existence of building codes designed to address risks identified in Essential 2 | | |
| Indicator 4: Combined share of natural space | 3.3.2. Green area per capita<br>3.3.4. Protected Natural Areas | 5.2 Access to nature<br>5.5 Sacred natural sites | | 5.1.2 - Ecosystem health<br>5.2.2 - Green and blue infrastructure is routinely embedded into city projects | | |
| Indicator 5: Level of species richness | | 1.2 Harmful harvest and trade<br>2.5 Invasive species<br>4.1 Animal species<br>4.2 Plant species<br>4.3 Functional diversity<br>4.4 Microbiota and fungi<br>4.5 Endemic species | | | Biodiversity | Terrestrial biodiversity<br>Freshwater biodiversity<br>Marine biodiversity |

| Park City Indicators | Urban Monitoring Framework | Urban Nature INdex | LEED for Cities | Urban Resilience Scorecard for Cities | Global Proximity Indicator System | Climate Bonds Resilience Taxonomy Methodology |
|---|---|---|---|---|---|---|
| Indicator 6: Level of natural science education | | 6.3 Education | | | Educational facilities | |
| Indicator 7: Atmospheric health | | 5.3 Human health | | | | |
| Indicator 8: Percentage of healthy water bodies that are safe and secure | 1.1.2 Safely managed drinking water services<br>1.1.3 Safely managed sanitation services | | Water Access and Quality<br>Water Performance | 5.2.2 - Green and blue infrastructure is routinely embedded into city projects | Sanitation<br>Drinking water | Wastewater collection & treatment |
| Indicator 9: Soil pollution prevention and control | | | Solid Waste Management<br>Waste Performance<br>Special Waste Streams Management<br>Smart Waste Management | 4.1.3 - Agricultural land at risk | Solid waste management | |
| Indicator 10: Friendliness of solid waste disposal | 3.1.2. Solid Waste Collection and Disposal | 1.1 Material consumption | | | Sanitation | Solid waste management |
| Indicator 11: Spatial coupling of urban parks | 3.2.1. Access to Open Public Spaces | | | 5.2.2 - Green and blue infrastructure is routinely embedded into city projects | | |
| Indicator 12: Perceived greenness of streets | | | | 5.2.2 - Green and blue infrastructure is routinely embedded into city projects | | |
| Indicator 13: Level of friendliness of public services | 1.2.1 Basic services | | | | | |
| Indicator 14: Level of green mobility | 1.1.8 Trafic fatalities<br>1.2.2 Access to public transport<br>2.2.3 Use of Public transport | | Transportation Performance<br>Clean Transportation | | Public transport and mobility<br>Commuting | Construction/operation of Transmission networks<br>Construction/operation of Railways |

| Park City Indicators | Urban Monitoring Framework | Urban Nature INdex | LEED for Cities | Urban Resilience Scorecard for Cities | Global Proximity Indicator System | Climate Bonds Resilience Taxonomy Methodology |
|---|---|---|---|---|---|---|
| Indicator 15: Participation in urban parks | | 6.5 Incentives and participation | Green Spaces | | | |
| Indicator 16: Proportion of population living longer | | | | | | |
| Indicator 17: Combined attractiveness of the population | 5.1 Exposure to nature | | | | | Tourism |
| Indicator 18: Consumption richness of life | | | | | | |
| Indicator 19: Participation in public events | | 5.2.1 Participation in Urban planning and Management | | | | |
| Indicator 20: Effectiveness of urban carbon sequestration | 3.4 Vegetation cover | 3.3.3. Change in tree cover | Energy Efficiency | "5.2.2 - Green and blue infrastructure is routinely embedded into city projects" | | |
| Indicator 21: Level of ecosystem services | 3.2 Ecosystem restoration (terrestrial) | | Ecosystem Assessment | 4.1.3 - Agricultural land at risk | | Animal production<br>Agro-forestry<br>Fishing<br>Other aquacultural production<br>Wholesale of agricultural produce<br>Commercial timber production |
| Indicator 22: Ecological water use intensity | | 3.1.1. Wastewater safely treated | Water Access and Quality<br>Water Performance<br>Integrated Water Management<br>Smart Water Systems | | | |
| Indicator 23: Societal labor productivity | | | | | Employment | |

| Park City Indicators | Urban Monitoring Framework | Urban Nature INdex | LEED for Cities | Urban Resilience Scorecard for Cities | Global Proximity Indicator System | Climate Bonds Resilience Taxonomy Methodology |
|---|---|---|---|---|---|---|
| Indicator 24: Innovation-driven capabilities | | | Innovation | | | |
| Indicator 25: Level of education of the labor force | | | | | Educational facilities | Child education |
| Indicator 26: Level of urban carbon emissions | 1.3 Greenhouse gas emissions from energy | 3.4.1. Total greenhouse gas emissions per year | Energy and Greenhouse Gas Emissions Performance | | | |
| Indicator 27: Percentage of non-fossil energy | | 3.3.1. Renewable energy share | Energy and Greenhouse Gas Emissions Performance | | | Hydropower generation<br>Wind power generation<br>Solar power generation<br>Geothermal generation<br>Nuclear power generation<br>Biomass generation |
| Indicator 28: Degree of transmission of historic resources | | | | | Cultural facilities | Preservation of cultural heritage |
| Indicator 29: Perception of historical memory | | 4.1.2. Cultural Knowledge<br>4.2.1 Access to culture | | | Cultural facilities | Preservation of cultural heritage |
| Indicator 30: Enrichment of cultural spaces | | 4.4.3 Open space for culture | | | Cultural facilities | Management of cultural facilities (e.g. museums, libraries, art galleries, concert halls) |
| Indicator 31: Degree of revitalization of historical heritage | | | | | Cultural facilities | Preservation of cultural heritage |
| Indicator 32: Cultural Brand Recognition | | 4.2.2 Cultural participation | | | | |
| Indicator 33: Contribution of cultural industries | | 4.3.1 Cultural employment<br>4.3.2 Expenditure on heritage | | | | Management of cultural facilities (e.g. museums, libraries, art galleries, concert halls) |

| Park City Indicators | Urban Monitoring Framework | Urban Nature INdex | LEED for Cities | Urban Resilience Scorecard for Cities | Global Proximity Indicator System | Climate Bonds Resilience Taxonomy Methodology |
|---|---|---|---|---|---|---|
| Indicator 34: Openness of links | | | | | | |
| Indicator 35: Cultural diversity | | 4.4.1 Sustainable management of heritage | | | | |
| Indicator 36: Social inclusion | | 1.2.7 Welfare of migrants | | | | |
| Indicator 37: Level of governmental regulation | 6.2 Legislation and regulation | | | 1.1.2 - Consultation in plan making | | |
| Indicator 38: Level of rule of law in social governance | | 5.2.3 Proportion of seats held by women in subnational/ local governments<br>5.2.4 Legal frameworks for equality | | | | |
| Indicator 39: Level of rule of law in the business environment | | | | | | |
| Indicator 40: Openness of feedback channels | | | | 1.1.3 - Review of strategic plans | Local administration access | |
| Indicator 41: Participation in development decision-making | | | | 1.1.2 - Consultation in plan making | Local administration access<br>Citizens participation | Public awareness |
| Indicator 42: Participation of multiple actors | | | | 1.1.2 - Consultation in plan making | Citizens participation | Public awareness |
| Indicator 43: Level of intellectual support | | 5.2.2. Utilization of E-Governance and Digital Governance Tools | | | Internet access | |

| Park City Indicators | Urban Monitoring Framework | Urban Nature INdex | LEED for Cities | Urban Resilience Scorecard for Cities | Global Proximity Indicator System | Climate Bonds Resilience Taxonomy Methodology |
|---|---|---|---|---|---|---|
| Indicator 44: Extent of smart applications | | | | | E-governance | |
| Indicator 45: Effectiveness of government governance | | 5.4.3 Governance of culture<br>5.2.5. Efficiency in urban governance | | | | |

Table: Overlap Analysis of Bench Frameworks

### 3.3.5 Key Findings

**The Park City Index (PCI)** stands out for its local-level focus, offering tailored metrics that align closely with urban challenges, such as cultural diversity, labour productivity, and green development. its innovative and specific indicators that provide actionable insights for urban policymakers. The index would benefit from integrating broader governance, biodiversity, and ecosystem sustainability measures to align with global frameworks.

**The Urban Monitoring Framework (UMF)** demonstrates a comprehensive and systematic approach to assessing urban sustainability. It emphasizes governance, public service delivery, and climate change mitigation, providing a macro-level perspective. Due to its broad focus, it tends to lack localized, granular indicators which are crucial for addressing city-specific challenges.

**The IUCN Urban Nature Index (UNI)** excels in biodiversity conservation and ecosystem health, offering specialized indicators for natural resource management and urban habitat connectivity. Its focus on ecosystem integrity and green spaces fills critical gaps but overlooks urban governance, cultural integration, and socio-economic indicators.

**The UNDRR Urban Resilience Scorecard for Cities (URSC)** provides a practical framework for assessing and enhancing urban resilience to disasters. It focuses on risk-informed governance, critical infrastructure, emergency preparedness, and financial resilience. Its strength lies in its alignment with the Sendai Framework for Disaster Risk Reduction and its applicability to multi-hazard scenarios. However, it pays limited attention to biodiversity and cultural-specific indicators, which are essential for long-term sustainability in diverse urban contexts.

**The LEED for Cities Certification System** offers a globally recognized benchmark for measuring and certifying a city's sustainability performance across categories like energy, water, waste, transportation, and quality of life. Its strength lies in integrating green building and environmental metrics with urban-scale outcomes. However, while strong on environmental performance, it may lack depth in areas such as cultural heritage, governance dynamics, and biodiversity.

**The UNESCO Culture|2030 Indicators** provide a structured framework for assessing the role of culture in sustainable urban development, aligned with the UN 2030 Agenda. They highlight dimensions such as cultural participation, education, heritage protection, and governance. This tool's strength lies in elevating culture as a central pillar of sustainability, although it does not fully address environmental or ecosystem-related indicators.

**The Proximity Indicator System** (associated with the 15-Minute City model) evaluates the spatial accessibility of essential urban functions within walkable or bikeable distances. Its key strength lies in spatial justice and livability, providing detailed geospatial analysis of neighbourhood-level access. It combines quantitative rigor with spatial visualization, making it actionable for urban planning, and also offers

a flexible evaluation system for local contexts - supporting scenario testing by adjusting service supply.

**The Common Reporting Framework (GCoM–CRF)** developed under the Global Covenant of Mayors enables cities to report their climate actions consistently, covering mitigation, adaptation, and risk assessment. Its strength is in its alignment with global climate frameworks like the Paris Agreement and SDG 13. It facilitates benchmarking and transparency across cities, although its scope is narrowly focused on climate and may lack integration with socio-cultural or biodiversity indicators.

| Framework | Strong Overlaps | Weak Overlaps |
|---|---|---|
| **UMF** | Social inclusion, public space, health, governance | Detailed economic indicators (e.g., unemployment rate) |
| **UNI** | Biodiversity, habitat connectivity, pollution, nature access | Detailed species-level biodiversity |
| **LEED** | Resource efficiency, building design, social equity | Detailed energy benchmarks, Greenhouse gas emissions |
| **GPIS** | Service equity, urban infrastructure | Mobility infrastructure, proximity, |
| **URS** | Risk awareness, basic infrastructure, governance coordination | Post-disaster operations, emergency logistics |
| **CBRT** | Land use, infrastructure, environmental co-benefits | Specific industry sectors (e.g., agriculture, finance) |

Table: Overlap Analysis of Bench Frameworks

# 4 Conclusion and Recommendations

## 4.1 Key Takeaways

Using a combination of typological review and semantic similarity analysis, this study examines how selected global and thematic tools conceptualize urban sustainability, structure indicator systems, and translate data into decision-support outputs.

The analysis identifies a **high level of thematic convergence** across frameworks in several core domains of sustainable urban development, particularly environmental quality, access to public services, public space provision, and human-centred urban form. At the same time, it reveals **notable differences** in methodological orientation, indicator resolution, and operational design. These variations reflect the distinct institutional mandates, scales of application, and governance contexts within which the tools operate, underscoring their largely complementary—rather than substitutive—roles within the broader urban monitoring landscape.

Within this comparative context, the Park City Index represents one approach among a range of integrative frameworks, with stronger coverage in domains related to liveability, ecological connectivity, service accessibility, and community-scale infrastructure. Its indicator structure is primarily oriented toward spatial planning and urban management, and appears most applicable in settings with relatively mature institutional arrangements and access to digital and spatial data. At the same time, the analysis indicates more limited coverage of dimensions such as risk preparedness, post-disaster recovery, sector-specific resilience, and financial or economic systems, which are addressed in greater depth by more specialized or operationally focused frameworks.

Overall, it suggest **opportunities for greater complementarity** between place-based assessment tools and global monitoring systems, including the UMF and SDG reporting processes. Strengthening alignment with internationally standardized indicators and methodologies could enhance comparability across tools, while preserving the contextual sensitivity of spatially oriented frameworks. More broadly, the results highlight the importance of connecting local and thematic assessment instruments with global monitoring architectures to improve coherence across scales and increase the policy relevance of urban sustainability metrics.

The recommendations presented in the following section build on these observations to inform the continued refinement and application of urban assessment tools. Emphasis is placed on enhancing **methodological robustness**, improving **cross-framework interoperability**, and supporting **adaptability** across diverse urban contexts, including cities in developing regions and resource-constrained environments. While informed by the analysis of the Park City Index, these recommendations are intended to **contribute to the wider evolution of urban monitoring practices**, in support of UN-Habitat's mandate to advance evidence-based, comparable, and actionable urban data systems.

### 4.1.1 Structural Similarities Despite Diverging Operational Models

The comparative analysis reveals a high degree of **structural convergence** across the evaluated urban assessment frameworks. Most tools organize indicators around **broadly shared thematic domains**—such as environment, economy, society, governance, and infrastructure—and are underpinned by **common normative principles**, including sustainability, inclusiveness, and resilience. Across frameworks, both qualitative and quantitative data are employed to capture multiple dimensions of urban performance, reflecting a shared effort to operationalize complex urban systems.

Despite these structural similarities, each framework derives its **distinct value** from differences in **operational design**, including data sources, methodological choices, and modes of result presentation. For example, while both the Park City Index (PCI) and the Urban Monitoring Framework (UMF) aim to assess urban prosperity and sustainability, they do so through different lenses. The PCI incorporates locally specific and context-sensitive indicators—such as digital visibility of public spaces—to capture aspects of cultural relevance and contemporary urban life. In contrast, the UMF is more closely aligned with global monitoring requirements, particularly SDG reporting, and emphasizes standardized indicators suited to public-sector performance tracking and international comparability.

Notable thematic overlaps are also observed between the **Proximity Indicator System, UNESCO Culture|2030 Indicators, and the PCI**, all of which address dimensions of urban liveability and cultural vitality. However, their analytical emphases differ. The Proximity Indicator System prioritizes spatial access to essential services and amenities; UNESCO Culture|2030 foregrounds cultural participation, heritage protection, and creativity; and the PCI places stronger emphasis on park-related urban quality of life and human–nature integration. These variations illustrate how shared thematic structures can mask

meaningful differences in analytical intent and policy orientation.

Taken together, these structural overlaps underscore the need for a more nuanced understanding of what constitutes effective urban assessment. Beyond the breadth of thematic coverage, key considerations include the depth of insight generated, the usability of outputs for decision-makers, and the operational feasibility of implementation across diverse urban contexts. Ultimately, the value of an assessment framework lies not only in the indicators it employs, but in **how its results are translated into evidence-based policies, targeted interventions, and institutional learning**.

The analysis further suggests that many existing tools function primarily as **conceptual "mind maps"**—effective in establishing shared terminology and framing urban challenges, but less effective in providing actionable guidance for implementation. To better support urban decision-making, assessment frameworks need stronger linkages to policy instruments, **mechanisms** for stakeholder engagement, and feedback loops that allow for iterative learning and adjustment over time. In this regard, **piloting indicators** across a diverse set of cities may offer a practical pathway to test relevance, coherence, and scalability, while ensuring that frameworks remain responsive to varied institutional capacities and development contexts.

### 4.1.2 Overall Coherence and Complementarity across Frameworks

The semantic similarity analysis indicates a moderate to strong level of coherence between the Urban Monitoring Framework (UMF), the Park City Index, and several thematic urban evaluation tools. This convergence reflects the increasing harmonization of global urban agendas, while also underscoring the challenges of differentiation among frameworks addressing overlapping dimensions of sustainable urban development. At the same time, the analysis highlights the complementary role of theme-specific tools—such as LEED for Cities, the Global Proximity Indicator System (GPIS), and the Urban Resilience Scorecard (URS)—in enriching UMF- and SDG-aligned monitoring processes by offering greater depth in selected domains.

The Park City Index demonstrates a coherent and well-structured conceptual foundation, integrating advanced perspectives on urban management, spatial planning, and governance. However, many of its indicators implicitly assume a high level of institutional maturity, digital governance capacity, and data availability, characteristics more commonly associated with well-developed urban contexts. The transferability and applicability of these indicators in developing country contexts, particularly in cities of the Global South or in resource-constrained and poverty-affected areas, require further examination.

### 4.1.3 Strong Alignment with Human-Centered and Environmental Dimensions

The highest levels of semantic alignment are observed with frameworks that prioritize human-scale urbanism, environmental quality, and proximity-based access to services. Tools such as the Urban Nature Index (UNI) and GPIS show strong thematic convergence with the Park City Index and UMF, particularly in areas related to green space provision, biodiversity integration, urban form, service accessibility, and social inclusion. This alignment reflects a shared commitment to promoting liveable, inclusive, and ecologically integrated urban environments.

### 4.1.4 Moderate Coherence with Integrated and System-Level Frameworks

Frameworks such as UMF and LEED for Cities adopt comprehensive, system-oriented indicator architectures, spanning social, environmental, economic, and governance dimensions. The analysis reveals a moderate degree of alignment among these tools, particularly around shared sustainability objectives related to public space, health, infrastructure, climate action, and energy performance. However, the Park City Index's emphasis on spatial liveability and urban form means that it does not fully capture certain quantitative performance metrics, such as energy use intensity or per-capita greenhouse gas emissions, which feature more prominently in LEED and UMF.

### 4.1.5 Lower Alignment with Operational Resilience and Finance-Oriented Frameworks

The Park City Index exhibits limited semantic overlap with operational and sector-focused frameworks such as URS and the Climate Bonds Resilience Taxonomy (CBRT). These tools place stronger emphasis on disaster preparedness, emergency response, recovery mechanisms, and financial resilience, including insurance, contingency funding, and sector-specific vulnerabilities. The divergence highlights existing gaps in risk governance, post-disaster recovery, and finance-related indicators within the Park City framework, which currently prioritizes urban form, accessibility, environmental quality, and spatial equity.

### 4.1.6 Indicator Clusters with High Cross-Framework Convergence

Across all benchmark frameworks, several indicator clusters consistently demonstrate strong thematic convergence:

- Public green space and ecological connectivity, particularly aligned with Natural Symbiosis and City–Park Integration dimensions;
- Accessibility of public services, including proximity to facilities and equitable service distribution;
- Community infrastructure and social participation, reflecting inclusive governance and civic engagement;
- Environmental health, encompassing air quality, exposure to nature, and environmental risk mitigation.

These clusters represent shared priorities across global urban sustainability and liveability agendas.

## 4.2 Gaps and Opportunities

### 4.2.1 Conceptual Alignment vs Implementation Effectiveness

A recurring gap across the reviewed frameworks is their predominant function as conceptual “mind maps”. These tools are effective in organizing complex urban sustainability themes and establishing a shared analytical language; however, they are less effective in directly supporting implementation, investment prioritization, and iterative decision-making at the city level.

Evidence from the comparative review indicates that the primary determinant of a tool’s impact is not the number or thematic breadth of indicators, but the extent to which the framework is **operationalized, adapted to local capacity**, and **embedded within governance and monitoring systems**. Frameworks that remain largely conceptual tend to be underutilized, whereas those that evolve through structured application, stakeholder engagement, and feedback mechanisms demonstrate stronger policy relevance and durability.

This distinction is reflected in existing practice. LEED for Cities, for example, translates assessment into action through a clearly defined operational workflow, including standardized evaluation procedures, third-party verification, and tangible incentives such as recognition and access to technical support. Similarly, the adaptation of the Singapore Biodiversity Index into Brazil’s BioSampa Index illustrates how thematically focused tools can be scaled through localization, institutional alignment, and data system integration.

By contrast, tools such as the Urban Nature Index and the Urban Resilience Scorecard provide robust conceptual and methodological foundations but often require additional investment in contextualization, capacity-building, and operational guidance to ensure consistent uptake across cities with differing technical and institutional capacities.

These observations directly inform the recommendations presented in Section 4.3. In particular, they underscore the need to **move beyond static indicator frameworks toward more dynamic, implementation-oriented systems**. Pilot applications across diverse urban contexts are essential to test feasibility, refine methodologies, and establish feedback loops. Such pilots can support the transition from conceptual frameworks to scalable analytical tools that are capable of tracking change over time, informing policy interventions, and contributing meaningfully to global monitoring efforts, including the SDGs and the Urban Monitoring Framework.

### 4.2.2 Financing and Economic Value as a Missing Link

Across the Park City Index (PCI), the Urban Monitoring Framework (UMF), the Urban Nature Index (UNI), and the Proximity Indicator System, financing and economic valuation emerge as the least developed dimensions. None of these frameworks currently provide

robust, quantitative indicators that explicitly link urban resilience, green infrastructure, or spatial equity to financial mechanisms or measurable economic returns. As a result, the economic case for investing in nature-based solutions, green mobility, and resilient urban systems remains insufficiently articulated within existing assessment approaches.

**Key climate- and sustainability-related economic dimensions**—such as carbon pricing mechanisms, emissions offsets, valuation of ecosystem services, and the economic contribution of green mobility—are largely absent from the PCI and other reviewed resilience-oriented tools. This represents a critical gap, given that these mechanisms constitute some of the most direct pathways through which urban environmental action can generate tangible economic value, attract investment, and support long-term fiscal sustainability.

While both the PCI and UNI acknowledge the importance of **ecosystem services**, their current treatment remains conceptually high-level and methodologically limited. Existing indicators tend to focus on presence or access, rather than capturing the full economic, regulatory, or risk-reduction value of ecological assets. Consequently, they fall short of providing a comprehensive or decision-relevant assessment of a city's ecological performance and value delivery, particularly from an investment or financing perspective.

This gap points to a significant opportunity for future framework development. Strengthening the integration of **economic valuation and financing-related indicators** would enable closer alignment between urban sustainability assessments and emerging climate finance, green bonds, and resilience investment agendas. Embedding such metrics could enhance the relevance of tools like the PCI for decision-makers seeking to justify investments, mobilize funding, and link urban resilience outcomes to broader economic and financial systems—an area of growing importance for cities across diverse development contexts.

### 4.2.3 Operational Readiness and Local Capacity Constraints

Beyond gaps in financing and economic valuation, the comparative analysis reveals a second critical limitation across many urban assessment frameworks: uneven operational readiness and local implementation capacity. While tools such as the Park City Index (PCI), the Urban Monitoring Framework (UMF), and other thematic indices are conceptually robust, their effective application **depends heavily on institutional capacity, data availability, and technical infrastructure at the city level**.

Many of the reviewed frameworks—including the PCI—assume a relatively high level of administrative coordination, digital governance, and data maturity. Indicators related to smart services, real-time monitoring, spatial analytics, or digital public engagement may be readily applicable in well-resourced cities, yet pose significant challenges for cities in developing countries, secondary cities, or contexts affected by informality and resource constraints. This creates a risk that assessment tools unintentionally privilege certain urban contexts, limiting their inclusiveness and global comparability.

**Operational barriers** are further compounded by fragmented data ecosystems. Cities often face constraints related to inconsistent data standards, limited interoperability between sectoral datasets, and reliance on irregular or externally sourced data. As observed in the implementation experience of UMF and SDG monitoring, gaps in baseline data and reporting capacity remain a persistent challenge, particularly in the Global South. Without clear guidance on data sourcing, validation, and updating cycles, indicators may remain aspirational rather than actionable.

In addition, many frameworks function primarily as conceptual or diagnostic instruments, offering **limited guidance on how results should translate into policy decisions**, investment prioritization, or programme design. The absence of structured feedback loops—linking assessment results to planning, budgeting, and monitoring processes—reduces the practical utility of these tools and weakens their potential to drive sustained urban transformation.

These findings highlight an important opportunity for future tool development and refinement. Strengthening operational readiness requires moving beyond indicator design to include **implementation guidance, adaptable data pathways, and capacity-sensitive methodologies**. This may involve offering tiered indicators, alternative data options (e.g. proxies, remote sensing, or participatory inputs), and clearer links between assessment outputs and policy or investment actions. By embedding operational feasibility into framework design, urban assessment tools can become more inclusive, scalable, and impactful across diverse urban contexts.

## 4.3 Recommendations

### 4.3.1 Recommendations for improvement of the Park City Index

#### a) Thematic Strengths and Blind Spots of the Park City Index

The Park City Index shows pronounced strengths in capturing urban liveability, with strong emphasis on public space quality, ecological networks, service accessibility, green mobility, and social inclusion. Its conceptual orientation aligns closely with human-centred and proximity-based planning paradigms, reinforcing its relevance for spatial equity and quality-of-life assessments.

However, the analysis also identifies key blind spots, particularly in relation to urban resilience and systemic risk management. Indicators addressing disaster preparedness, recovery planning, and sector-specific resilience—including finance, industry, and food systems—are comparatively underdeveloped. Addressing these gaps would strengthen the Park City Index's capacity to support more holistic and risk-informed urban development strategies.

#### b) Maintain and Strengthen Unique Contributions

The Park City Index (PCI) introduces several innovative parameters that distinguish it from other urban evaluation frameworks, particularly in addressing the challenges and opportunities of the information and digital era. Notably, the PCI includes indicators such as internet searchability, online openness of touristic and heritage sites, and connectivity to public space information - features largely absent in other mainstream indices. These components offer a new dimension to urban assessment and present potential complementary value to existing global frameworks, highlighting PCI's international relevance and forward-looking orientation.

In addition, PCI places strong emphasis on the living environment of the labour force, incorporating indicators related to productivity, educational attainment, and innovation capacity. This reflects a unique blend of urban prosperity and economic vitality perspectives, positioning PCI as an index that aligns urban development with industry and knowledge-based growth. However, these indicators primarily evaluate the city's performance rather than directly capturing the lived experiences of workers. Strenghening this area presents an opportunity for further refinement and enhancement of the tool.

#### c) Improve Indicator Validity and Ensure Alignment with Goals

Some indicators in the PCI would benefit from further examination of their relevance and alignment with the framework's overall goals.

For instance, PCI 16: Proportion of Long-lived Population raises questions about its interpretability and actionable value. Longevity is influenced by a complex interplay of historical, environmental, social, and psychological factors over decades, making it difficult to attribute directly to current urban interventions or park city strategies. Its inclusion may therefore obscure rather than clarify causal impacts. It is recommended that this indicator be reconsidered or replaced with metrics that better capture urban green contributions to present-day health and well-being, such as access to nature, air quality, mental health benefits, or physical activity levels.

#### d) Strengthen Educational Dimensions

The PCI emphasizes the value of cultural spaces, community participation, and smart applications, but overlooks a key enabling factor: education and awareness.

There are currently no indicators in the Index that reflect public education efforts around climate resilience, ecological awareness, or the cultural and historical importance of preservation. This presents an opportunity to strengthen PCI by integrating educational dimensions that enhance long-term behavioral and societal change.

#### e) Enable Greater Alignment with Existing Global Tools and Frameworks

The PCI can benefit from utilizing the strengths of existing global tools and frameworks to enhance its global applicability. In particular, the PCI can utilise frameworks such as the UMF to incorporate assessments of urban form and planning systems. UMF's indicators on efficient land use (3.4.2), neighborhood safety (1.1.6), and urban policy integration (5.4.2), as well as UNI's metrics on urban sprawl (2.1), land use patterns (3.1), and urban planning (6.1) are most relevant here.

### 4.3.2 The Way Forward: Recommendations and Directions for Future Development of Global Assessment Tools

#### a) From conceptual mapping to operational practice

Drawing on the six core functions of indicator frameworks identified by Pekka Halla and Albert Merino-Saum, the comparative review suggests that most existing comprehensive urban assessment frameworks—including the Park City Index—currently operate primarily as conceptual mind maps. In this role, they are effective in clarifying key dimensions of complex urban concepts, establishing a shared analytical language, and supporting interdisciplinary dialogue and mutual learning across institutions and sectors.

However, the broader ambition of the Park City Initiative extends beyond conceptual framing. Its objectives include not only articulating a holistic vision for green, low-carbon, and liveable urban development, but also enabling cities to track progress over time, benchmark thematic performance, diagnose strengths and gaps, identify development typologies, and facilitate peer learning through comparable case studies. These functions require a level of analytical depth and operational capacity that exceeds what a mind map–style framework can provide.

At present, many indicators within holistic frameworks are defined broadly in conceptual terms but are measured using single data points or static formulas. This limits their ability to capture dynamics, interdependencies, and trade-offs, and reduces their usefulness for decision-making, monitoring, and policy feedback.

#### b) Towards a radar-type analytical tool

To address these limitations, this study recommends that comprehensive frameworks evolve towards a radar-type analytical tool. Such a tool would retain the conceptual clarity of existing frameworks while enabling more granular, multi-dimensional, and actionable analysis. Specifically, a radar-type tool would be designed to:

- Integrate multiple data layers across thematic areas, sectors, and spatial scales;
- Incorporate dynamic and time-sensitive data to support trend analysis and progress tracking;
- Enable more nuanced assessments of strengths, gaps, and trade-offs across urban systems; and
- Generate outputs that are directly usable for planning, policy prioritization, and investment decision-making.

In doing so, the tool would move beyond conceptual mapping to support key analytical functions, including: (i) longitudinal monitoring, (ii) thematic benchmarking, (iii) development typology identification, and (iv) structured city-to-city learning based on comparable contexts.

### c) Strengthening alignment with global monitoring systems

Aligning analytical workflows, data standards, and outputs more closely with established global systems—such as UN-Habitat's Urban Monitoring Framework and SDG reporting mechanisms—would further enhance the value of such tools. Improved interoperability would enable thematic tools to contribute to global datasets, strengthen baselines, and support more coherent and comparable reporting on progress towards sustainable, inclusive, and resilient urban development.

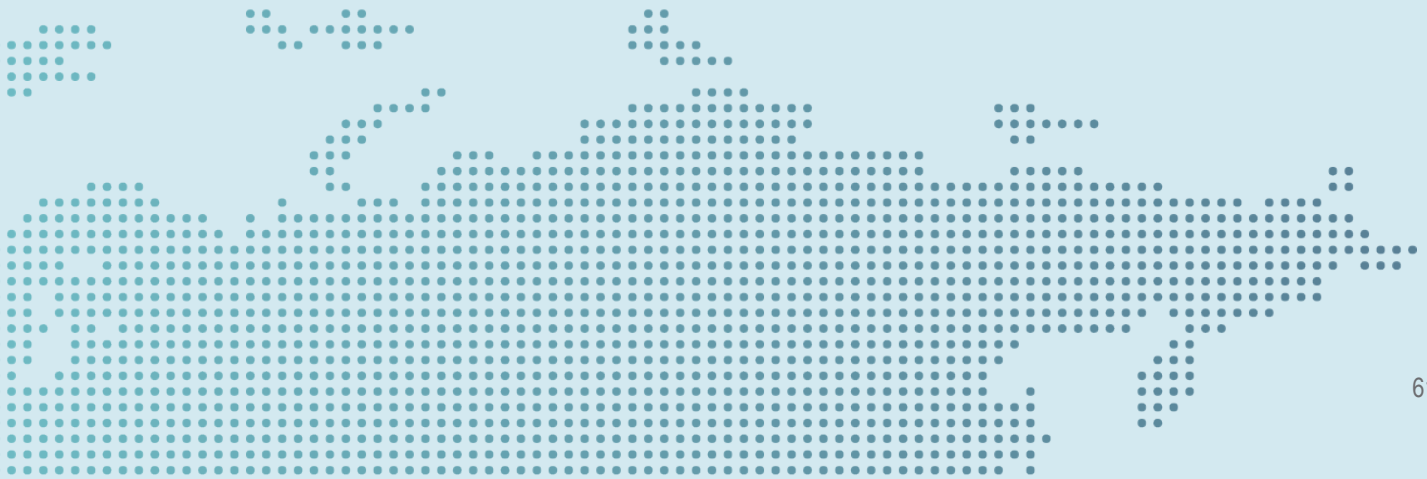
### d) Refinement over proliferation

The findings also underscore the importance of building on the strengths of existing frameworks rather than introducing additional conceptual models. Future efforts would benefit more from targeted, in-depth studies focused on specific thematic gaps or underdeveloped dimensions—such as financing, resilience governance, or ecological valuation—than from the creation of new overarching frameworks. Clear differentiation of purpose, thematic focus, and user group will be essential for maintaining relevance and avoiding duplication in an increasingly crowded assessment landscape.

### e) Enhancing local applicability through capacity-sensitive design

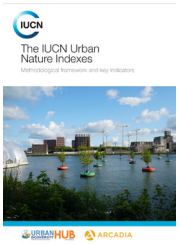
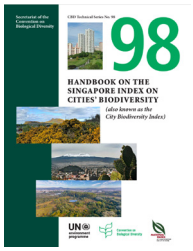
Finally, to ensure practical uptake by local governments and urban practitioners, future tool development should explicitly address data availability and institutional capacity. This includes offering multiple data pathways (e.g. proxies, remote sensing, participatory inputs), adaptable methodologies suited to different levels of technical maturity, and clear guidance on data collection and validation. Where appropriate, these efforts should be complemented by targeted training, technical assistance, and follow-up support.

Establishing long-term partnerships and sustainable financing mechanisms will be critical to sustaining these efforts. Such arrangements can support the continuous accumulation of local data and applied experience, enable iterative refinement of tools, enrich shared databases, and ultimately strengthen mutual learning and cross-city comparative analysis at both regional and global scales.

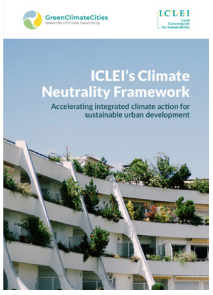
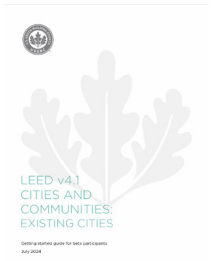
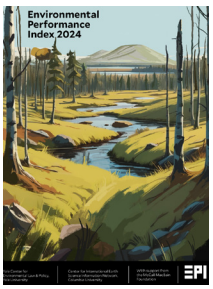


# ANNEX

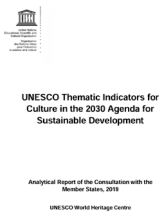
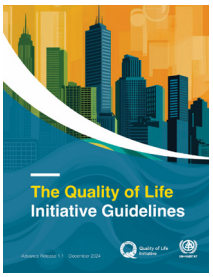
| Thematic Category | Framework/Tool | Lead Organization | Initial Release | Latest Update | Thematic Focus | T |
|---|---|---|---|---|---|---|
| Urban Sustainability | Urban Monitoring Framework (UMF) | UN-Habitat | 2020 | 2022 | Urban SDGs, sustainability, resilience | Nat governn |
| | Park City Index (PCI) | Research Center of Park City Index | 2022 | 2024 | Green city, ecological culture, livability, innovation | City plann |
| Biodiversity & Ecosystem | Urban Nature Index (UNI) | IUCN | 2021 | 2023 | Biodiversity, green space, urban nature | Loca conserv |
| | City Biodiversity Index (CBI/SBI) | Singapore National Park Board | 2008 | 2024 | Urban biodiversity and ecosystem integrity | Local |
| | BioSampa Index | Municipal SVMA of Sao Paulo | 2016 | 2023 | Urban biodiversity and social equity | Municip Pau |
| Urban Resilience & Risk Prevention | City Resilience Index | Arup + Rockefeller Foundation | 2015 | 2019 | Urban resilience (systems-based) | City resi |
| | Urban Resilience Scorecard | UNDRR | 2015 | 2017 | Disaster risk reduction & resilience planningw | Local p |

| Target Users | Scale | Geographical Focus | Data Intensity | Output Type | Methodology Type | Cover |
|---|---|---|---|---|---|---|
| tional and local ments, UN agencies | City | Global | wMedium | Reporting/Data Platform | Indicator-Based Frameworks |   |
| y governments, hers, think tanks | City | China | Medium–High | Benchmarking report | Indicator-Based Frameworks | |
| al governments, ration organizations | City | Global | High | Benchmarking report | Indicator-Based Frameworks |   |
| authorities, CBD focal points | City | Global | Medium | Diagnostic Profile with decision-making suggestions | Indicator-Based Frameworks |   |
| al government (São ulo), academia | City | Brazil | High | Diagnostic Profile with decision-making suggestions | Indicator-Based Frameworks |   |
| y governments, lience planners | City | Global | High | Benchmarking report | Indicator-Based Frameworks |   |
| authorities, DRR practitioners | City | Global | Medium | Diagnostic Profile with decision-making suggestions | Assessment & Scoring Tools |   |

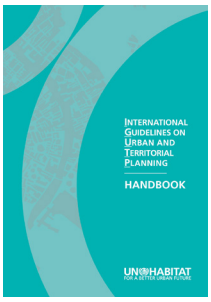
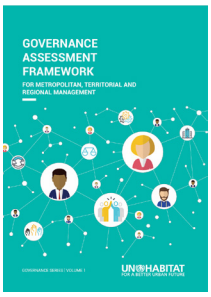
| | | | | | | |
|---|---|---|---|---|---|---|
| Green City & Climate Mitigation & Low Carbon | ICLEI Climate Neutrality Framework | ICLEI + ACCCRN | 2018 | 2020 | GHG neutrality, low-carbon development | Local g |
| | Green City Index | Siemens + EIU | 2009 | 2009 | Environmental performance in urban areas | C resea |
| | Common Reporting Framework (GCoM – CRF) | Global Covenant of Mayors (GCoM) | 2018 | 2024 | Climate mitigation, adaptation, and risk | GCoM cli |
| | Green Growth Indicators (OECD) | Organisation for Economic Co-Operation and Development (OECD) | 2011 | 2017 | Green economy, resource efficiency, decoupling | Na govern |
| | LEED for Cities | US Green Building Council (USGBC) | 2017 | 2021 | Sustainable cities, green building, operations | City susta |
| | Environmental Performance Index (EPI) | Yale Center for Environmental Law & Policy and CIESIN–Columbia University, in collaboration with WHO, WEF, and the EU JRC | 2006 | 2024 | National environmental health and ecosystem vitality | Policym glob |
| | EU Green City Tool | European Commission | 2009 | 2009 | Urban sustainability performance (EU aligned) | Local a |

| | | | | | | |
|---|---|---|---|---|---|---|
| governments, ICLEI members | City | Global | Medium–High | | Policy/ Guideline-Based Frameworks |  |
| ity managers, archers, investors | City | EU → Global | Medium | Benchmarking report Ranking (Rating System) | Indicator-Based Frameworks |  |
| M signatory cities, mate networks | City | Global | High | Ranking (Rating System) Reporting/Data Platform | Indicator-Based Frameworks |  |
| ational & local nments, economists | National | Global | High | Ranking (Rating System) | Indicator-Based Frameworks |  |
| y governments, ainability officers | City | USA → Global | High | Certification System (Verification) | Assessment & Scoring Tools |  |
| nakers, researchers, al benchmarking entities | National | Global | Medium–High | Diagnostic Profile with decision-making suggestions Reporting/Data Platform | Modelling & Valuation Tools |  |
| uthorities in Europe | City | EU | Medium | Benchmarking report | Indicator-Based Frameworks | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Social & Cultural Inclusion & Life Quality | OECD Better Life Index | OECD | 2011 | 2020 | Well-being, life satisfaction, QoL | Policy |
| | Proximity Indicator System | IAE Paris Sorbonne Business School (Chaire ETI), C40 Cities, United Cities and Local Governments (UCLG) and UN-Habitat | 2023 | 2024 | Urban services accessibility, proximity, 15-min city | Urba govern |
| | Social Inclusion Index | UNDP, Development Bank of Latin America (CAF) | 2016 | 2019 | Equity, access, opportunity, social participation | Gove |
| | UNESCO Culture 2030 | UNESCO | 2019 | 2025 | Culture's contribution to sustainable development | Na gove |
| | Quality of Life Index (QoLI) | UN-Habitat, UNECA | 2019 | 2023 | Urban living quality: housing, mobility, health, environment, equity | City |
| | ISO 37120: Indicators for City Services & Quality of Life | International Organization for Standardization (ISO) | 2014 | 2018 | Urban services, infrastructure, life quality | Citi certifi |
| Finance | Climate Resilience Principles | Climate Bonds Initiative | 2021 | 2024 | Investment-focused resilience standards | Ci infrast |
| | CDP Cities, GCoM CRF | CDP, GCoM | 2016 | 2024 | Climate emissions, mitigation, adaptation | Cities gl |
| | Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) | Natural Capital Project (Stanford University) | 2007 | 2024 | Ecosystem services valuation (carbon, water, biodiversity, etc.) | Enviro eco |

| | | | | | | |
|---|---|---|---|---|---|---|
| y analysts, public, researchers | Nation | OECD/Global | Medium | Ranking (Rating System) | Indicator-Based Frameworks |   |
| an planners, local ments, researchers | City/ Neighborhood | Global | High | Diagnostic Profile with decision-making suggestions Benchmarking report | Assessment & Scoring Tools | |
| ernment agencies, researchers | City | LAC | Medium | Benchmarking report | Policy/ Guideline-Based Frameworks | |
| ational and city rnments, cultural institutions | City/National | Global | Medium–High | Benchmarking report | Indicator-Based Frameworks |   |
| y governments, planners | City | Global | High | Benchmarking report | Policy/ Guideline-Based Frameworks |   |
| es pursuing ISO cation, statisticians | City | Global | High | Certification System (Verification) | Assessment & Scoring Tools |   |
| ties, investors, ructure developers | City | Global | Medium | Benchmarking report | Assessment & Scoring Tools |   |
| , GCoM members, obal coalitions | City | Global | High | Benchmarking report Reporting/Data Platform | Indicator-Based Frameworks |   |
| onmental planners, nomists, NGOs | Site–National | Global | High | Diagnostic Profile with decision-making suggestions | Modelling & Valuation Tools |   |

| | | | | | | |
|---|---|---|---|---|---|---|
| Governance | International Guideline of Urban Territorial Planning (IG-UTP) - Planning System Assessment | UN-Habitat | 2015 | 2023 | Urban and territorial planning systems, institutional frameworks, enabling conditions, governance, legal frameworks, and capacity assessment | Nation gover aut p |
| | SDG Cities diagnostic tools | UN-Habitat | 2021 | 2025 | Local SDG readiness, governance, integrated planning, financing, data capacity, project pipeline | City munici authori |
| | GAF-MTR (UN-Habitat) | UN-Habitat | 2020 | 2020 | Metropolitan governance | Reg |

| | | | | | | |
|---|---|---|---|---|---|---|
| al and subnational rnments, planning thorities, urban policymakers | National/ subnational | Global | Medium | Benchmarking report | Policy/ Guideline-Based Frameworks |  |
| y governments, ipal planners, local ties, urban analysts | City | Global | Medium | Benchmarking report | Policy/ Guideline-Based Frameworks |  |
| gional planners | Region/City | Global | Medium | Benchmarking report | Policy/ Guideline-Based Frameworks |  |

# LIST OF ABBREVIATIONS

| | |
|---|---|
| **ACCCRN** | Asian Cities Climate Change Resilience Network |
| **CAF** | Development Bank of Latin America (Corporación Andina de Fomento) |
| **CBI** | City Biodiversity Index (same as SBI) |
| **CBRT** | Climate Bonds Resilience Taxonomy Methodology |
| **CDDC** | Chengdu Design Consulting Group |
| **CDP** | Carbon Disclosure Project |
| **CIESIN** | Center for International Earth Science Information Network |
| **CPI** | City Prosperity Index |
| **CRF** | Common Reporting Framework |
| **DRR** | Disaster Risk Reduction |
| **EIU** | Economist Intelligence Unit |
| **EPI** | Environmental Performance Index |
| **ESG** | Environmental, Social, and Governance |
| **ETI** | Chaire Entrepreneuriat Territoire Innovation (IAE Paris Sorbonne Business School) |
| **EU** | European Union |
| **GAF** | Governance Assessment Framework |
| **GCI** | Green City Index |
| **GDP** | Gross Domestic Product |
| **GHG** | Greenhouse Gas |
| **GIS** | Geographic Information System |
| **GPIS** | Global Proximity Indicator System |
| **IAE** | Institut d'Administration des Entreprises (IAE Paris Sorbonne Business School) |
| **ICLEI** | Local Governments for Sustainability (originally International Council for Local Environmental Initiatives) |
| **IG-UTP** | International Guideline of Urban Territorial Planning |
| **ISO** | International Organization for Standardization |

| | |
|---|---|
| **IUCN** | International Union for Conservation of Nature |
| **LAC** | Latin America and the Caribbean |
| **LEED** | Leadership in Energy and Environmental Design |
| **GAF-MTR** | Governance Assessment Framework for Metropolitan, Territorial and Regional Management |
| **OECD** | Organisation for Economic Co-operation and Development |
| **PCI** | Park City Index |
| **PPP** | Public–Private Partnership |
| **RCPCI** | Research Center of Park City Index |
| **SBI** | Singapore Biodiversity Index (same as CBI) |
| **SDG** | Sustainable Development Goal |
| **SFDRR** | Sendai Framework for Disaster Risk Reduction |
| **STNAAC** | Sichuan Tianfu New Area Administrative Committee |
| **SVMA** | Secretaria do Verde e do Meio Ambiente (São Paulo Municipal Secretariat for Green and Environment) |
| **TESSA** | Toolkit for Ecosystem Service Site-based Assessment |
| **TF** | Term Frequency–Inverse Document Frequency |
| **UCL** | University College London |
| **UCLG** | United Cities and Local Governments |
| **UMF** | Urban Monitoring Framework |
| **UN** | United Nations |
| **UN-Habitat** | United Nations Human Settlements Programme |
| **UNDRR** | United Nations Office for Disaster Risk Reduction |

# ENDNOTES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